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Contents

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CONTENTS
Volume 36

BERENTS, PENELOPE B. *Warragaia rintouli* n. gen., n. sp. (Amphipoda: Urohaustoriidae) from New South Wales, Australia 253

FLENNIKEN, J. JEFFREY & J. PETER WHITE. Australian flaked stone tools: a technological perspective 131

HOESE, DOUGLASS F. & RUDIE H. KUITER. A revision of the Australian plesiopid fish genus *Paraplesiops*, with notes on other Australian genera 7

_____ See Rennis, Denise S. 169

HOLLIS, J.D. & F.L. SUTHERLAND. Occurrences and origins of gem zircons in eastern Australia 299

HUNT, GLEN S. Taxonomy and distribution of *Equitius* in eastern Australia (Opiliones: Laniatores: Triaenonychidae) 107

JAIRAJPURI, M. SHAMIA. See Orton Williams, Ken J. 1

JEEKEL, C.A.W. Millipedes from Australia, 6: Australiosomatini from Victoria (Diplopoda: Polydesmida: Paradoxosomatidae) 19

KUITER, RUDIE H. See Hoese, Douglass F. 7

LOWRY, J.K. Systematics of the pachynid group of lysianassoid Amphipoda (Crustacea 51

_____ Two new species of *Cerapus* from Samoa and Fiji (Crustacea: Amphipoda: Ischyroceridae) 157

_____ & G.C.B. POORE. The ampeliscid amphipods of south-eastern Australia (Crustacea) 259

MCALPINE, DAVID K. The Australian genera of Heleomyzidae (Diptera: Schizophora) and a reclassification of the family into tribes 203

NG, PETER K.L. & LEO W.H. TAN. *Globopilumnus multituberosus* Garth & Kim, 1983 — a new record for Australia (Decapoda: Crustacea: Menippidae) 127

ORTON WILLIAMS, KEN J. & M. SHAMIA JAIRAJPURI. Observations on the morphology and systematics of *Thalassogenus* Andrássy, 1973 (Nematoda: Thalassogeneridae n. fam.) ... 1

MOORE, G.C.B. See Lowry, J.K. 259

RENNIS, DENISE S. & DOUGLASS F. HOESE. A review of the genus *Parioglossus* with descriptions of six new species (Pisces: Gobioidei) 169

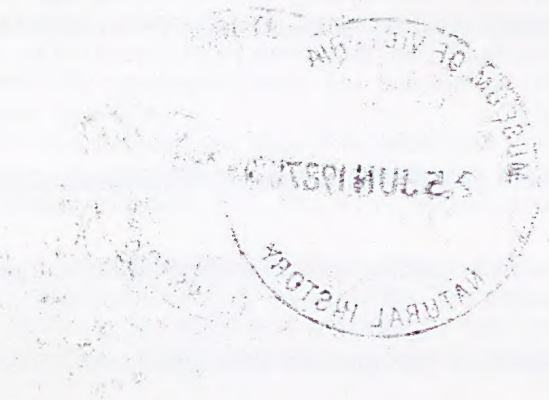
SADLIER, ROSS A. A new Australian scincid lizard, *Menetia concinna*, from the Alligator Rivers region, Northern Territory 45

_____ A new Australian scincid lizard, *Ctenotus coggeri*, from the Alligator Rivers region, Northern Territory 153

SUTHERLAND, F.L. See Hollis, J.D. 299

TAN, LEO W.H. See Ng, Peter K.L. 127

WHITE, J. PETER. See Flenniken, J. Jeffrey 131



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NATIONAL MUSEUM
25 JUN 1984
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Observations on the morphology and systematics of *Thalassogenus* Andrássy, 1973 (Nematoda: Thalassogeneridae n.fam.) ..... KEN J. ORTON WILLIAMS and M. SHAMIA JAIRAJPURI Page 1

A revision of the Australian plesiopid fish genus *Paraplesiops*, with notes on other Australian genera .... DOUGLASS F. HOESE and RUDIE H. KUITER Page 7

Millipedes from Australia, 6: Australiosomatini from Victoria (Diplopoda: Polydesmida: Paradoxosomatidae) ..... C.A.W. JEEKEL Page 19

A new Australian scincid lizard, *Menetia concinna*, from the Alligator Rivers region, Northern Territory ..... ROSS A. SADLIER Page 45

Systematics of the pachynid group of lysianassoid Amphipoda (Crustacea) .... J. K. LOWRY Page 51

LUME 36 NUMBERS 1 & 2 15 JUNE 1984

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RECORDS OF THE AUSTRALIAN MUSEUM

3 MAY 1985
NATURAL HISTO

Taxonomy and distribution of *Equitius* in eastern Australia (Opiliones: Laniatores: Triaenonychidae)..... GLEN S. HUNT Page 107

Globopilumnus multituberosus Garth & Kim, 1983 — a new record for Australia (Decapoda: Crustacea: Menippidae)..... PETER K.L. NG & LEO W.H. TAN Page 127

Australian flaked stone tools: a technological perspective..... ..... JEFFREY J. FLENNIKEN & J. PETER WHITE Page 131

A new Australian scincid lizard, *Ctenotus coggeri*, from the Alligator Rivers region, Northern Territory..... ROSS SADLIER Page 153

Two new species of *Cerapus* from Samoa and Fiji (Crustacea: Amphipoda: Ischyroceridae ..... J.K. LOWRY Page 157

A review of the genus *Parioglossus* with descriptions of six new species..... ..... DENISE S. RENNIS & DOUGLASS F. HOESE Page 169

LUME 36 NUMBERS 3 & 4 19 APRIL 1985

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The Australian Genera of Heleomyzidae (Diptera: Schizophora) and a Reclassification of the Family into Tribes ..... DAVID K. MCALPINE Page 203

Warragaia rintouli n.gen., n.sp. (Amphipoda: Urohaustoriidae) from New South Wales, Australia. ..... PENELOPE B. BERENTS Page 253

The Ampeliscid Amphipods of South-eastern Australia (Crustacea) .... J.K. LOWRY AND G.C.B. POORE Page 259

Occurrences and Origins of Gem Zircons in Eastern Australia..... .....J.D. HOLLIS AND F.L. SUTHERLAND Page 299

LUME 36 NUMBERS 5 & 6 JUNE 11 1985

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Observations on the Morphology and Systematics of *Thalassogenus* Andrássy, 1973 (Nematoda: Thalassogeneridae n.fam.)

KEN J. ORTON WILLIAMS* and M. SHAMIM JAIRAJPURI†

Commonwealth Institute of Parasitology, 395A Hatfield Road, St. Albans, Herts AL4 0XU, U.K.

ABSTRACT. *Thalassogenus archaeops* n.sp., the second species belonging to the extraordinary enoplid genus of predatory terrestrial nematodes first described by Andrássy (1973), is described from Western Samoa. The importance of the arrangement of the stoma, structure of the cardia and its accompanying glands, and the presence of an eye-spot and six caudal glands is discussed and a new family Thalassogeneridae is proposed for the genus.

ORTON WILLIAMS, KEN. J. & M. SHAMIM JAIRAJPURI, 1984. Observations on the morphology and systematics of *Thalassogenus* Andrássy, 1973 (Nematoda:Thalassogeneridae n.fam.) Records of the Australian Museum 36(1):1–5.

In recent years a number of unusual nematodes have been discovered in Australia, New Zealand and the islands of the Central and South Pacific, resulting in the erection of several genera that have not always fitted easily into existing classifications. During preliminary examination of material from a survey of Pacific Island groups collected by one of us (KJOW) in 1976-1977, an interesting nematode, apparently a mononch, was noted in a single sample. On closer investigation it proved to belong to the monotypic enoplid genus *Thalassogenus* Andrássy, 1973, which was described from Papua New Guinea. Our species, from Western Samoa, though closely related to the generitype, *T. paradoxus* Andrássy, 1973, represents a new species. The observations on its morphology given in the description below throw more light on this remarkable genus and its affinities.

Materials and Methods

Specimens were heat-fixed in F.A. 4:10, cleared in warm lactophenol and processed to a glycerine mountant containing traces of picric acid by a modified Baker method. One female and the single juvenile were processed to the same mountant by a glycerine-alcohol slow evaporation technique.

Thalassogenus archaeops n.sp.

Figs 1-18

Dimensions. *Females (4)*: L = 1.66–1.90 mm (mean 1.81); a = 29–34 (31); b = 4.3–4.7 (4.4); c = 34–47 (38); V = 59–62 (61).

Holotype female: L = 1.9 mm; a = 30; b = 4.7; c = 36; V = 62.

Description. *Females.* Body stout, an open spiral on heat death with a slight taper anteriorly and posteriorly. Cuticle smooth, about 3.5 μm at base of lip region, 3.5–4.5 μm at midbody, increasing to 5 or 6 μm on tail. Hyaline portion of terminus 6–8 μm thick.

Lip region continuous, 36–41 μm wide at level of amphid apertures, flattened anteriorly to produce a truncate outline. Lips six, four submedian and two lateral, rounded, each bearing two projecting labial papillae, one on the inner and one on the outer side. Papillae consisting of small convex base thinning abruptly to short setose apex and arranged in two circles; the inner circle with narrower bases inclined towards the mouth, the outer circle with wider bases inclined outwards. Four additional submedian cephalic papillae present at level of amphids. Amphid aperture a small slit about 3.5 μm wide, located at 32–34 μm from the base of stoma, leading into a large sensillar pouch about 8 μm wide which extends posteriorly to a maximum of 15 μm from amphid aperture.

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Stoma barrel-shaped, 22–23 μm wide by 41–47 μm long, composed of a set of three vertical plates and a set of three oblique plates. The vertical plates are larger and unarmed, and slope inwards anteriorly to form an aperture 8–9 μm across below the mouth. The basal oblique plates (oesophagostome) each bear a prominent tooth which occupies 20–25% of stomal length and comes to a point 9–11 μm above stomal base. Teeth of equal size arranged in a circle about 120° apart, one dorsal and two subventral. Oesophageal glands opening through dorsal tooth. Oesophagus surrounding oblique plates at anterior end, strongly muscular, terminating 380–430 μm from lip region. Lumen highly cuticularized. Neither oesophageal glands nor orifice visible in oesophagus. Nerve ring 147–165 μm from anterior, connected by means of a short commissure to an eye-spot (ocellus) sited midventrally 20–33 μm behind anterior edge of nerve ring, 167–187 μm from lip region.

Eye-spot heart-shaped in optical section, 9–14 μm long, composed of two functionally distinct parts: photoreceptive and sensory. The small dark pigment granules that constitute the photoreceptor cover the outer surface of the eye-spot except at its apices; the curved side, which lies directly beneath the body cuticle, having more granules because of its greater size than the flatter and smaller inner surface, which is pressed against the oesophagus. From this it would seem that although light is mainly received ventrally through the cuticle, it can also be detected coming dorsally through the body. The sensory portion, visible at the anterior but mainly at the posterior end, consists of a cell (or cells?) joined anteriorly to the nerve commissure. Cuticle bulging slightly over ocellus probably acting as a lens. In ventral view (1 ♀) eye-spot 12 μm long by 15 μm wide, attached along its anterior edge to a strap-like extension of the nerve ring.

Cardia muscular, 38–48 μm long with four large gland cells arranged sublaterally around the oesophageal-intestinal junction. Cardia with a complicated system of branching tubules which may represent ducts of the cardiac gland cells, although neither the point of origin nor the course of these tubules is clear. Intestine a single layer of cells with a wide lumen. Anterior intestinal cells with long, filamentous microvilli which disappear gradually away from the oesophageal-intestinal junction. Gut contents include several different nematodes, intact or partially digested, including the remains of odontostyles and spicules. Paired trophi of rotifers were also seen. Prerectum absent. Rectum 30–36 μm long by 25 μm wide (measured in one female), dorsoventrally flattened. Anus a large curved slit, 30 μm wide (1 ♀) about 70% of anal body width.

Reproductive system di-amphidelphic; ovaries reflexed, the flexed portion of the posterior branch extending past vulva in three out of four specimens (the exception being young with an incompletely developed reproductive system). Anterior ovary lying mainly on the left side of the body; posterior ovary on the right side (in one paratype both ovaries were on the right). Tip of ovaries turned dorsally. Oocytes few, large, with large nuclei, in a single row. Oviduct and uterus undifferentiated. The single uterine egg measured a massive 218 × 42 μm. Vagina short, 10–11 μm, less than 20% of vulval body width. Vulva a transverse slit.

Tail bluntly conoid, convex dorsally, flat to slightly concave ventrally, 39–53 μm long, 0.9–1.3 anal body widths. Body width at anus 38–45 μm. Caudal glands large and prominent, six in number, arranged in tandem in two sets of three. Anterior glands preanal in position. Gland nuclei prominent. Each gland with a separate duct which leads to a well developed sexpartite sac. This in turn connects with the outside via a narrow duct through the terminal cuticle, its opening sunk in a small circular cuticular pit.

Juvenile female: Stoma 13 μm wide by 28 μm long armed with three teeth. Replacement teeth absent. Eye spot, four cardiac glands and six caudal glands present. Other characteristics as in adult.

Male: Not found. Spermatozoa not present in uteri of females.

Diagnosis. *T. archaeops* n.sp. is closely related to *T. paradoxus* Andrássy, 1973 but can be differentiated by its smaller body length (1.66–1.90 mm compared to 2.3–2.5 mm in *T. paradoxus*), smaller length of buccal cavity (41–47 μm compared to 61–63 μm), truncate lip region, inward orientation of the inner ring of labial papillae, amphid apertures that are slit-like not pore like and presence of four cardiac glands not three. According to the original description *T. paradoxus* possessed three caudal glands. However, examination of a female and the juvenile paratype showed that six glands were actually present arranged in three pairs as in *T. archaeops*. The generic diagnosis is accordingly emended.

Type habitat and locality. Soil around roots of taro *Colocasia esculenta* (L.) Schott at 3,000 ft (914 m) on Mt Mata o le Afi, Savai'i Island, Western Samoa. Collected September 1976.

Type material. The holotype, one female paratype and one juvenile have been deposited at the Commonwealth Institute of Parasitology, St. Albans, Herts, England. An additional female, cut and mounted in several ways is in the same collection. One further female paratype is with the Department of Zoology, Aligarh Muslim University, Aligarh, India.

Etymology of specific epithet. *Archaeops*, Greek from αρχαιος = ancient + ωψ = eye.

Discussion

Andrássy (1973) considered *Thalassogenus* a true marine residual because of several of its unusual morphological features, in particular the presence of an eye-spot which had hitherto been reported only in marine nematodes. He placed *Thalassogenus* in the order Enoplida Chitwood, 1933; suborder Oncholaimina De Coninck, 1965; superfamily Pelagonemoi-

toidea De Coninck, 1965 and family Pelagonematidae De Coninck, 1965.

Thalassogenus bears a strong resemblance to predatory nematodes of the order Monochida Jairajpuri, 1969, particularly forms such as *Cobbonchus* or *Miconchus*. This lead Jensen (1976) to the belief that it was not a member of the Pelagonematidae but belonged in either the Tripyloidea De Man, 1876 or the Mononchida. Lorenzen (1981) took this one step further and transferred *Thalassogenus* to the family Mononchidae Filipjev, 1934 of the order Mononchida because of its stoma, oesophagus and tail.

Our study clearly shows that despite superficial resemblances, *Thalassogenus* cannot be a member of the Mononchida because it possesses partly setose papillae (papillae in the Mononchida are mamilliform), a stoma composed of unarmed vertical plates and armed oblique plates (only the vertical plates are ever armed in the Mononchida), oesophageal gland ducts opening through the dorsal tooth (not into the oesophageal lumen) and cardiac glands and an eye-spot (both of which are absent in the Mononchida). We consider these differences to be of a fundamental nature and agree with Andrássy's classification of the genus in the Enoplida, Oncholaimina and Pelagonematoidea. However, we do not accept its placement with the Pelagonematidae. In our opinion the characters of the stoma and the presence of an eye-spot in a terrestrial nematode justify the creation of a new family. This is formally set out below.

The position of the eye-spot in *Thalassogenus,* its mode of connection to the nerve ring, its lenticular shape in optical cross section, its greater width than length in ventral view, even the fact that the cuticle has to bulge over it slightly to accommodate it are all very reminiscent of the hemizonid of the Tylenchoidea and it is not impossible that the hemizonid and eye-spot are homologous structures.

This is not to suggest that *Thalassogenus* is a near relative of the tylenchs; rather, its two species appear to have evolved from a single marine form that came ashore, adapted to a terrestrial predatory habit, speciated and left its descendants as relicts on their respective mountains separated by nearly 4000 kilometres of sea.

Family THALASSOGENERIDAE n.fam.

Diagnosis. Pelagonematoidea. Stoma large, vertical plates unarmed, basal oblique plates armed with three sharply-pointed teeth of equal size, apices directed anteriorly. Oesophagus very muscular, cylindrical. Cardiac glands large. Single eye-spot present immediately posterior and ventral to nerve ring. Two sets of three caudal glands present. Predatory, terrestrial.

Type and only genus. *Thalassogenus* Andrássy, 1973.

Generic diagnosis (emended). Head with six lips bearing two rings of six papillae. Papillae setose at least in part. Four additional cephalic papillae borne at level of amphid apertures. Amphid apertures small, pore-like or slit-like, in anterior half of buccal cavity. Buccal cavity barrel-shaped, longer than wide, mainly parallel, sided, composed of vertical and oblique plates, the latter forming the base and armed with three teeth of equal size, one dorsal, two sublateral. Oesophagus cylindrical, muscular. Eye-spot present immediately posterior and ventral to nerve ring, connected to it by short commissure. Cardiac glands prominent. Female gonads paired, reflexed. Tail rounded with six caudal glands arranged in two lines of three. Sexpartite terminal sac present communicating to exterior by fine duct. Juveniles similar to female except for gonad development, replacement teeth absent. Male unknown.

Type species: *T. paradoxus* Andrássy, 1973.

Other species: *T. archaeops* n.sp.

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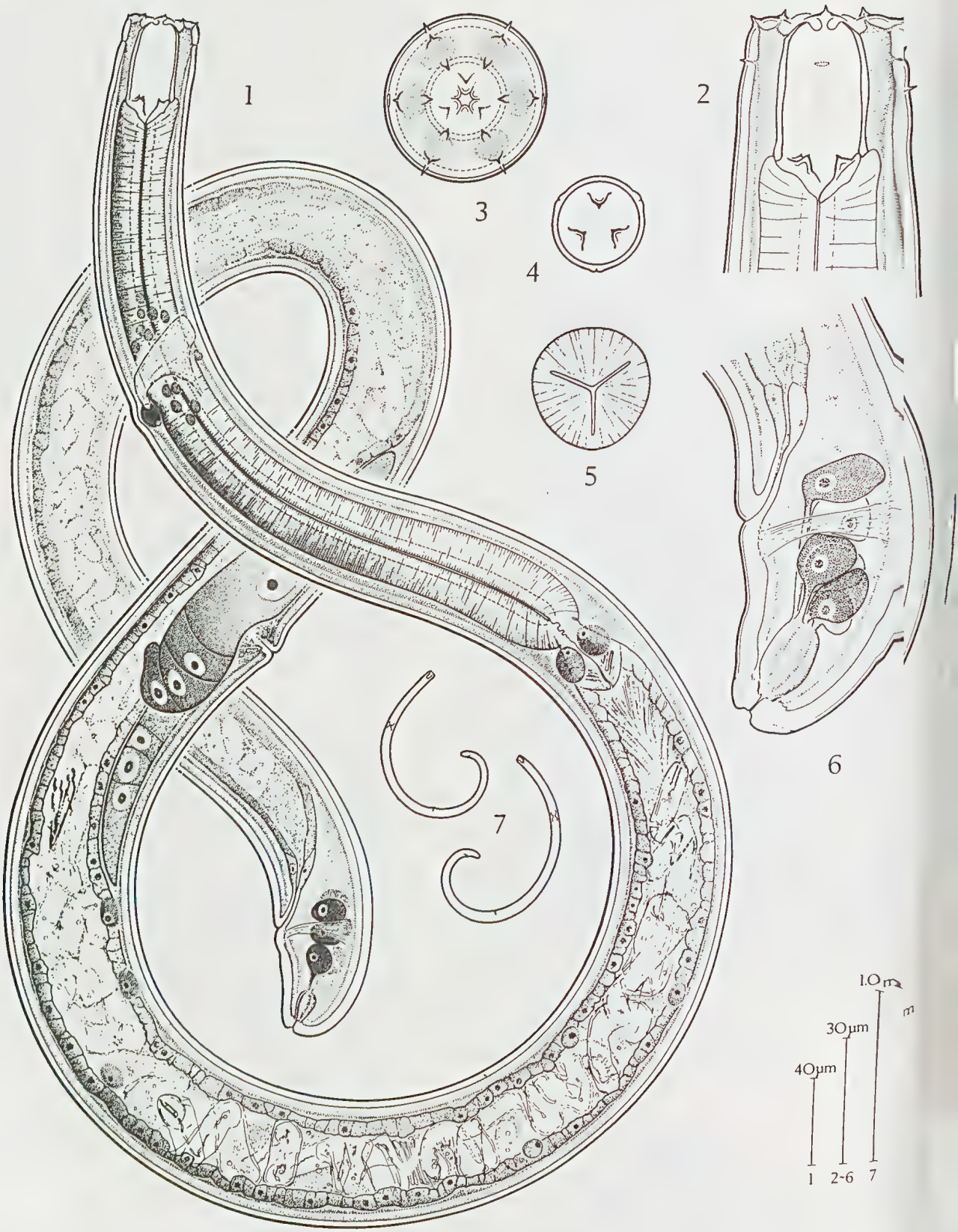
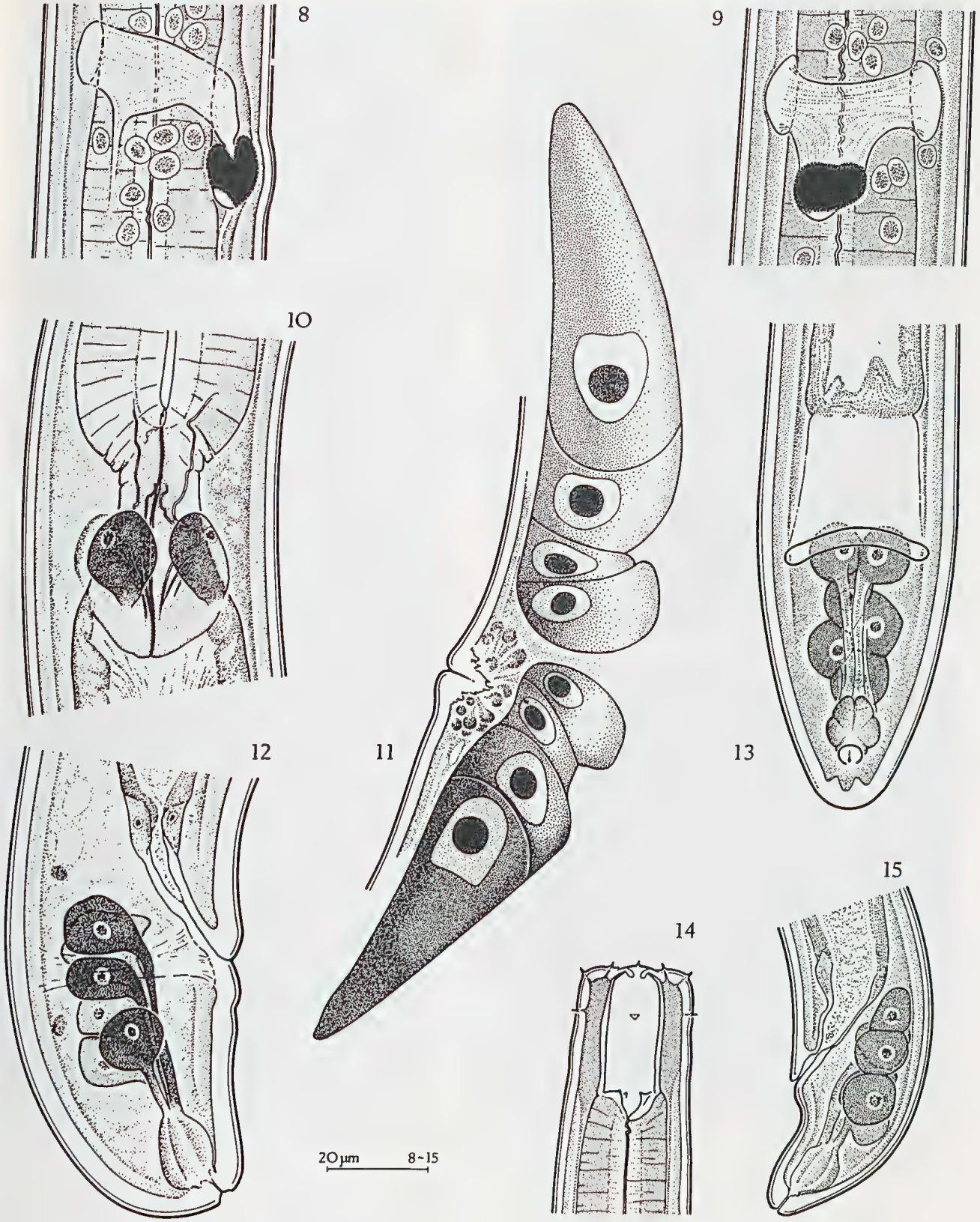
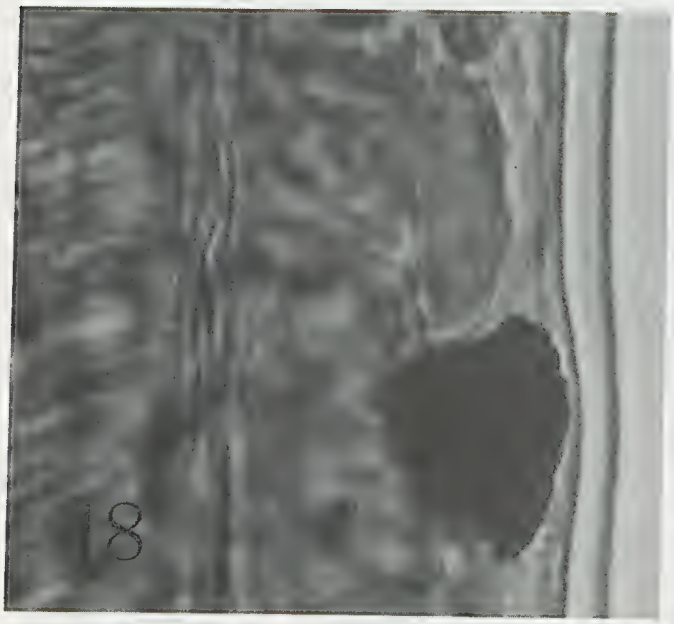


Figs 1–7. *Thalassogenus archaeops* n.sp. adult female. **1**, entire animal. **2**, anterior end. **3**, face view. **4**, cross-section of stoma. **5**, cross-section of oesophagus near stoma. **6**, posterior end. **7**, habitus.



Figs 8–15. *Thalassogenus archaeops* n.sp. **8–13,** adult female. **8,** nerve ring and eye-spot, lateral. **9,** nerve ring and eye-spot, ventral. **10,** oesophageal-intestinal junction showing cardiac glands. **11,** reproductive system. **12,** posterior end (see also Fig. 6). **13,** posterior end, ventral view. **14,** juvenile, anterior end. **15,** juvenile, posterior end.



Figs 16–18. *Thalassogenus archaeops* n.sp., adult female. **16 & 17**, anterior end. **18**, detail of eye-spot.

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A Revision of the Australian Plesiopid Fish Genus *Paraplesiops*, with Notes on Other Australian Genera

DOUGLASS F. HOESE[a] and RUDIE H. KUITER[b]

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ABSTRACT. The species of the Australian endemic genus *Paraplesiops* are reviewed. Three previously described species (*P. poweri, P. bleekeri* and *P. meleagris*) are recognized and *P. alisonae* is described as new. *Paraplesiops meleagris* is shown to vary geographically in scale and gill raker counts. A key is provided to Australian plesiopid genera, and characteristics are given to allow identification of genera.

HOESE, DOUGLASS F., & RUDIE H. KUITER. A revision of the Australian plesiopid fish genus *Paraplesiops*, with notes on other Australian genera. Records of the Australian Museum 36(1): 7-18.

The genus *Paraplesiops* is restricted to subtropical and temperate rocky and coral reefs of Australia. Most species are cryptic, occurring in caves and under ledges. Little taxonomic work has been done on the group. Ogilby (1918) reviewed the Queensland species, and provided a key distinguishing five species, of which only three are recognized here. All the species were regarded as allopatric and little was known of their interrelationships. Subsequently the junior author discovered a fourth undescribed species, differing considerably in morphology from other Australian species.

Also, little information was available on other Australian plesiopid genera until the works of Allen and Kuiter (1976) and Allen (1977). Recent collections have been made of *Calloplesiops* from Australia. It has also been found that *Fraudella*, originally described as a serranoid, belongs with the plesiopids. Currently six plesiopid genera are known from Australia, three endemic. Since literature on the family is scattered, a key is presented here to aid identification of the genera.

Materials and Methods

Counts and measurements follow Hubbs and Lagler (1958). Lateral line counts include pored scales from the upper lateral line running along the back, and the lower lateral line running along the midside to the base of the caudal fin. The longitudinal scale count is taken in a line from the end of the operculum to the caudal base, excluding small scales on the caudal fin. Lower gill raker counts are from the outer face of the first arch, beginning at the angle and including rudiments.

Material used for the study is deposited in the following institutions: Australian Museum, Sydney (AMS); National Museum of Victoria, Melbourne (NMV), Queensland Museum, Brisbane (QM), South Australian Museum, Adelaide (SAM), Western Australian Museum, Perth (WAM), and Division of Fisheries, CSIRO, Cronulla (CSIRO).

The following material was used in preparing Table 1 and the key to genera: *Assessor flavissimus*—AMS I.19445-108, 1(26), Lizard Island, Queensland. *Assessor macneilli*—AMS I.15682-035, 55(13-53), One Tree Island, Queensland. *Calloplesiops altivelis*—AMS I. 15684-032, 2(85-95), One Tree Island, Queensland. *Fraudella carassiops*—AMS IA.5093, 1(43), holotype, North-west Islet, Queensland; AMS IA.6302, 7(29-43), paratypes, North-west Islet, Queensland; QM I.12388, 1(44), north of North Keppel Island, Queensland. *Trachinops brauni*—AMS I.20245-018, 23(17-45), Rottnest Island, Western Australia. *Trachinops caudimaculatus*—AMS I.17550-005, 4(49-60), Port Arthur, Tasmania. *Trachinops noarlungae*—AMS I.20181-009, 1(66), Kangaroo Island, South Australia. *Trachinops taeniatus*—AMS I.18241-020, 60(10-65), Port Hacking, New South Wales. *Plesiops oxycephala*—AMS I.15681-043, 17(37-80), One Tree Island, Queensland. *Plesiops cephalotaenia*—AMS I.15634-017, 1(70), One Tree Island, Queensland. *Plesiops coeruleolineatus*—AMS I.19460-051, 1(49), Decapolis Reef, Queensland.

Australian Plesiopid Genera

The six plesiopid genera recognized from Australia are compared in Table 1.

Whitley (1935) described *Fraudella* in the Hypoplectrodidae (= Serranidae) and recorded I, 5

Table 1. A comparison of Australian Plesiopid genera.

Character	*Assessor*	*Plesiops*
Teeth on tongue	+	–
Teeth on vomer	–	+
Maxilla scaled	+	–
Head scaled forward to snout	+	–
Preopercular margin	smooth	smooth
Second dorsal base	scaled	scaled
Pores on preoperculum	largely confined to around eye & pop margin	covers ⅓–
Dorsal spine membranes incised	weakly	deeply
Lateral line pores (upper)	covered	minute lat
Mandibular pores	uniserial	multiserial
Gill rakers on first arch	very elongate	short
Pelvic rays prolonged	slightly	+
Scales with distinct centres & radiating lines	–	+
Outer row of teeth enlarged	–	+
Caudal fin	forked	rounded t
Dorsal spines	11	
Dorsal rays	8–11	
Anal rays	9–11	
Pectoral rays	14–16	
Upper lateral line scales	34–39	
Lower lateral line scales	2–9	

pelvic rays. Böhlke (1960) placed *Fraudella* with the Grammidae. Re-examination of the type material shows that all specimens have I, 4 pelvic rays and a body form characteristic of *Plesiops*. *Fraudella carassiops* Whitley is known from two localities on the Great Barrier Reef. Allen (1977) revised the Australian genus *Trachinops*. Allen and Kuiter (1976) reviewed the tropical western Pacific genus *Assessor*. McCosker (1978) recognized only a single species of *Calloplesiops, C. altivelis* (Steindachner), from the Indo-west Pacific. Inger (195 revised *Plesiops,* although there are difficulti identifying some Australian species.

Springer (1982) suggested that the family may not monophyletic. Further studies are necessary determine the relationships of *Assessor, Trachinops* a *Calloplesiops* to the three typical plesiopid genera.

Kuiter (1979) has figured all species of *Trachino* and *Paraplesiops* in colour.

Key to Australian Plesiopid Genera

1. Preopercular margin serrated, with numerous teeth along whole margin. Dorsal spines usually XIII ..... *Fraudella*

—— Preopercular margin smooth, or rarely denticulate at angle of preoperculum. Dorsal spines XI–XV 2

2. Caudal fin forked. Maxilla scaled. Top of head scaled forward to tip of snout. No vomerine teeth ..... *Assessor*

—— Caudal with rounded margin or elongate. Maxilla naked. Top of head naked from above eye to tip of snout. Vomerine teeth present 3

aplesiops	*Fraudella*	*Calloplesiops*	*Trachinops*
+	+	–	–
+	+	+	+
–	–	–	–
–	–	–	–
oth–denticulate	serrated	smooth	smooth
ngle			
ed–scaled	naked	scaled	naked
rs ⅓–½ of pop	cover total	confined to around eye & pop margin	confined to around eye & pop margin
ly	weakly	weakly	weakly
red or exposed	covered	exposed	covered, scales notched posteriorly
iserial	uniserial anteriorly	uniserial	uniserial
t	short	elongate	very elongate
±	–	+	±
–	–	–	–
+	+	–	+
ded to elongate	rounded	elongate	rounded to elongate
11–12	12–13	11	11–15
9–11	9	9–10	16-21
9–11	9–10	9	17–23
17–19	17	18–19	14–18
28–43	16–23	19–24	38–90
9–21	1–9	9–12	0–18

3. Body very elongate, body depth 4–5 in SL. Dorsal rays XI–XV, 16–21 ..... *Trachinops*

—— Body robust, body depth 2.5 to 3.5 in SL. Dorsal rays XI–XIII, 6–11 4

4. Mandibular pores uniserial. Teeth in outer row of upper jaw not distinctly enlarged. Preopercular pores confined to a narrow band around eye and along preopercular margin. Dorsal membranes weakly incised ..... *Calloplesiops*

—— Mandibular pores multiserial. Teeth in outer row of upper jaw distinctly enlarged. Preopercular pores cover ⅓–½ of preoperculum. Dorsal membranes deeply incised between spines 5

5. No teeth on tongue. Soft dorsal rays 6–8. Upper lateral line scales 17–30. Scales with unmarked centres and prominent radiating lines extending from centre ... *Plesiops*

—— Tongue with teeth. Soft dorsal rays 9–11. Upper lateral line scales 28–43. Scales with normal circulae and radiating lines posteriorly only ..... *Paraplesiops*

Paraplesiops

Bleeckeria Castelnau, 1873a: 14 (type species *Bleeckeria catafracta* Castelnau, by monotypy).

Ruppelia Castelnau, 1873b: 51 (type species *Ruppelia prolongata* Castelnau, by monotypy).

Paraplesiops Bleeker, 1875: 3 (type species *Plesiops bleekeri* Günther, by original designation).

Acanthogonia Ogilby, 1918: 45 (type species *Paraplesiops poweri* Ogilby, by subsequent designation by McCulloch, 1929).

Paraplesiops is readily distinguished from other Australian plesiopid genera in characteristics given in Table 1. All species have 15 branched caudal rays and pelvics I, 4. In general body form, dentition and gill

raker size, the genus is most similar to the tropical genera *Plesiops* and *Fraudella*. Species of *Paraplesiops* are cryptic, often found in caves on coral and rocky reefs. The genus is endemic to Australia.

Although the name *Paraplesiops* has been widely accepted, Castelnau (1873a, 1873b) erected two earlier names for this genus. Unfortunately the manner in which he introduced the names has caused considerable confusion. Castelnau apparently started with two unrelated species, a plesiopid and an anthiine. In an early paper in 1873, Castelnau applied the name *Bleeckeria catafracta* to the plesiopid, and then indicated in a later paper (1873b: 44 & 51) that the usage was a lapsus calami, since he had apparently intended to use this name for the anthiine. He then described the anthiine as *Lacepedia catafracta* and indicated that *Lacepedia* was a substitute name for his earlier genus (*Bleeckeria*), which he considered preoccupied (by *Bleekeria* Günther). In the same paper he described the plesiopid as *Ruppelia prolongata*.

It is apparent that Castelnau intended to name the anthiine as *Bleeckeria*, replace it with *Lacepedia*, and name the plesiopid as *Ruppelia*. However, he applied the name *Bleeckeria* to the plesiopid, replaced it with *Lacepedia* and described the anthiine as *Lacepedia* at the same time. It is questionable whether the use of *Bleeckeria* represents a lapsus calami, since it is not apparent in the original publication (Castelnau, 1873a) that an error had occurred. There is also some uncertainty over the status of *Lacepedia*. *Bleeckeria* is not preoccupied. *Ruppelia* is effectively regarded as preoccupied by Opinion 27 of the International Commission on Zoological Nomenclature.

Additional confusion has occurred over the placement of *Lacepedia*. Castelnau (1873b) indicated that it might be a cirrhitid, but that only one or two lower pectoral rays could have been unbranched. Jordan (1923) placed it in the Cirrhitidae, but McCulloch (1929) placed the genus in the Aplodactylidae. However, the dentition, serrated preoperculum, teeth, body form, and meristics given by Castelnau (1873b) suggest an anthiine, agreeing most closely with *Caesioperca*.

Since there is considerable confusion over the names *Bleeckeria, Ruppelia,* and *Lacepedia,* and since none of these names has been used as a senior synonym for over 100 years we follow other workers and accept *Paraplesiops* in the interests of stability.

Key to Species of *Paraplesiops*

1. Dorsal spines usually XI. Posterior dorsal and anal rays and pelvic rays not prolonged; longest dorsal ray 22–25% of SL; pelvic fin 26–34% of SL. Body moderately slender, depth at pelvic origin 3.1 to 3.7 in SL. No scales on dorsal and anal fin bases. Eye small 7–8.6% of SL in adults. Victoria to Western Australia and northern Tasmania ..... *P. alisonae* n. sp.

—— Dorsal spines usually XII. Posterior dorsal and anal rays and pelvic rays greatly prolonged; longest dorsal ray 29–50% of SL; pelvic fin 34–51% of SL. Body deeper, 2.3 to 2.9 in SL. Bases of dorsal and anal fins scaled. Eye larger, 8–14% of SL in adults 2

2. Preopercular margin denticulate. Pectoral rays 18–20, rarely 18. Upper lateral line scales 28–32. Body with 8–10 narrow black vertical bands. Queensland and northern New South Wales ..... *P. poweri*

—— Preopercular margin smooth. Pectoral rays 16–19, rarely 19. Upper lateral line scales 34–43. Body uniformly dark or with 4–5 broad black vertical bands 3

3. Body distinctly banded, with 4 or 5 broad black vertical bands. Lower lateral line scales 11–14. Exposed preopercular scales in a broad patch extending from behind eye to near posterior preopercular margin, 8–11 rows between eye and angle of preoperculum. Southern Queensland and New South Wales ..... *P. bleekeri*

—— Body uniform blue to black. Lower lateral line scales 12–21, rarely fewer than 15. Exposed preopercular scales confined to a narrow band before posterior preopercular margin, 2–7 rows between eye and angle of preoperculum. Victoria to Western Australia ..... *P. meleagris*

Paraplesiops alisonae n. sp.

Figs 1–3

Diagnosis. Dorsal rays XI-XII (rarely XII), 9–10 (rarely 9). Anal rays III, 9–11 (rarely 9 or 11). Other meristics shown in Tables 2–9. Pelvic fin elongate, 26.4–33.8% of SL reaching to between second anal spine to third soft ray. Caudal fin rounded, 23.2– 28.4% of SL. Posterior dorsal rays only slightly elongate, longest ray 21.7–25.4% of SL. Body slender, depth at pelvic origin 26.4–32.2% of SL. Preopercular margin smooth. Preopercular scales largely exposed (Fig. 1); naked along posterior preopercular margin; preopercular and cheek pores confined to narrow band along posterior preopercular margin and immediately behind and below eye. Mandibular pores few, in isolated clusters (Fig. 2) Top of head scaled forward to above middle of preoperculum, ending well behind eye. No scales along bases of dorsal and anal rays.

Coloration in alcohol: Head and body light to dark brown. Head with numerous small dark brown to bluish-black widely spaced spots; spots much smaller than pupil diameter; spot on lower operculum subequal in size to other head spots. No dark line above upper lip. Body sometimes with scattered small faint brown spots. Pelvic and pectoral fins whitish to dusky. Median fins dusky to black. Dorsal and anal fins normally with three or four white longitudinal stripes.

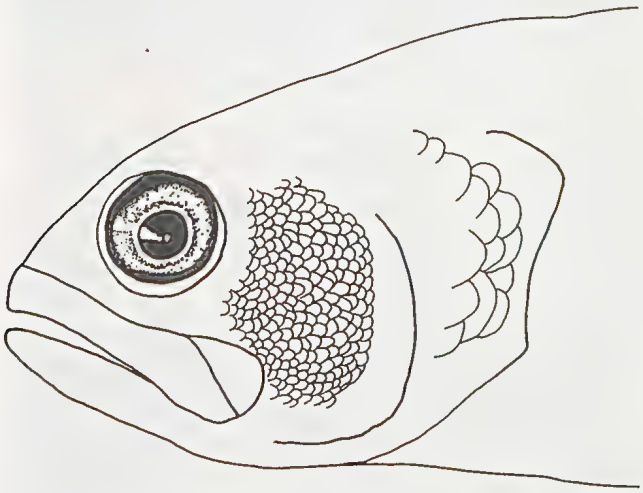

Fig. 1. Camera lucida drawing of the head of *Paraplesiops alisonae*, showing exposed preopercular scales.

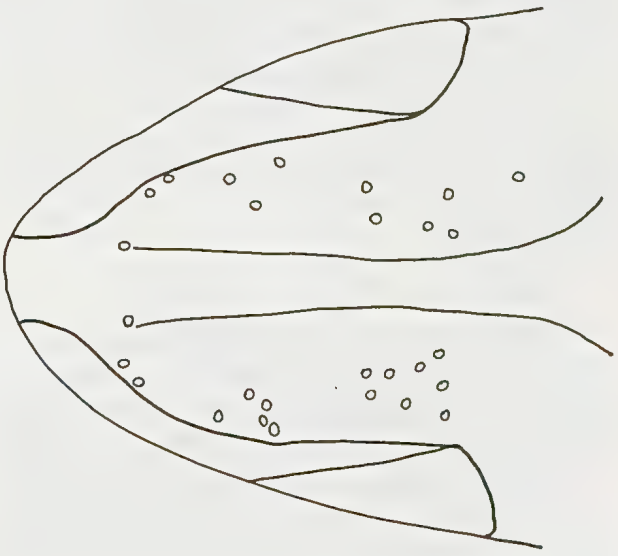

Fig. 2. Camera lucida drawing of lower surface of head of *Paraplesiops alisonae*, showing arrangement of head pores.

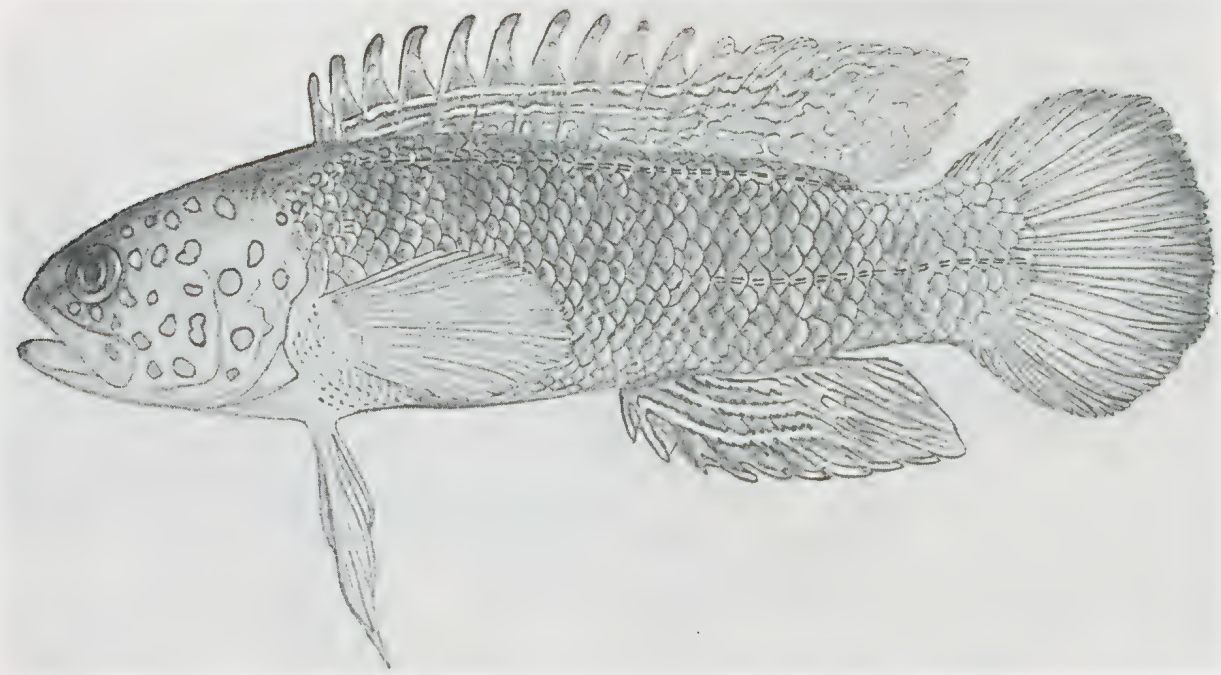

Fig. 3. Holotype of *Paraplesiops alisonae*, AMS I.19921-013, 107 mm SL. Drawing by R. Kuiter.

Live coloration: Head and body brown. Head spots iridescent blue. Body with 7–10 narrow dark brown vertical bars, most prominent in males and juveniles. Dorsal and anal fins with 2 or 3 longitudinal blue stripes; tips of rays blue. A thin blue posterior caudal margin. Females darker and with broader stripes on dorsal and anal fins.

Description. Membranes connecting dorsal spines deeply incised, connecting lower half of spines, membrane sloping downward posteriorly. Membranes between dorsal soft rays and anal rays weakly incised, connecting more than three-quarters of rays. Pectoral margin rounded. Eye subequal to snout. Mouth large, reaching below to behind end of eye. Outer row of teeth in jaws stout and short; inner teeth thinner. Tongue with a large oval patch of small teeth. Gill rakers much shorter than gill filaments. Body scales ctenoid, cycloid on belly, pectoral base, breast, top and sides of head. Jaws and lower surface of head naked. Upper lateral line extends to caudal peduncle just behind end of dorsal fin. Lower lateral line begins approximately under last dorsal spine, extending 2 or 3 scales onto caudal base; no notched scales.

Etymology. Named for Alison Kuiter.

Relationships. *Paraplesiops alisonae* differs from all other species of *Paraplesiops* in having short dorsal and caudal rays, in being more slender-bodied, with a body form superficially similar to species of *Plesiops,* and in lacking scales on the dorsal and anal bases. *Paraplesiops alisonae* is most similar to *P. bleekeri* in having the lower preopercular-mandibular pores grouped into clusters and in having the cheek scales largely exposed and not covered by pores. In *P. meleagris* and *P. poweri,* the preopercular mandibular pores are dense and more or less evenly spaced, and most of the cheek scales are embedded.

Material examined. HOLOTYPE—AMS I.19921-013, 1(107), Portsea Pier, Port Phillip Bay, Victoria; coll. R. Kuiter, 30 July 1977.

PARATYPES—AMS I.19921-014, 1(115), taken with holotype. AMS I.20078-002, 1(90), Grassy Port, King Island, Tasmania; coll. B. Russell, 5 Dec. 1977, 3–7 m. AMS I.20089-003, 1(55), Port Davies, Flinders Island, Tasmania; coll. B. Russell and C. Short, 3 Jan. 1978, 1 m. AMS I.20174-001, 1(118), Knob Point, Kangaroo Island, South Australia: coll. B. Russell, 6 Mar. 1978, 3–8 m. AMS I.21706-001, 1(93), Ricketts Point, Port Phillip Bay, Victoria; coll. R. Kuiter, Oct. 1979. NMV A.3145 2(34-106), Portsea Pier, Port Phillip Bay, Victoria; coll. R. Kuiter. SAM F.4730 1(105), The Rip, Point Lonsdale, Port Phillip Bay, Victoria; coll. R. Kuiter. WAM P.21736-005, 3(72-107), off Kings Beach, Victor Harbour, South Australia; coll. B. Hutchins.

Non-Type Material—WAM P.26006-001 2(123-123), Mondrain Island, Western Australia. WAM P.27578-001, 2(55-100), Barrell Rock, Tamar River mouth, Tasmania.

Paraplesiops bleekeri

Fig. 4

Plesiops bleekeri Günther, 1861: 364 (locality unknown).

Diagnosis. Dorsal rays XII, 10. Anal rays III, 9-1((rarely 9). Other meristics shown in Tables 2–9. Pelvi fin very elongate, 39.4–48.4% of SL, reaching t between second anal spine to sixth soft ray. Caudal fi elongate, 32.6 to 40.5% of SL. Soft dorsal elongate i adult, longest ray 39.5–51.9% of SL. Body deep, dept at pelvic origin 32.6–38.9% of SL. Preopercular margi smooth. Preoperculum with numerous minute pores i narrow band around margin of eye and near posterio preopercular margin; most of cheek covered wit medium-sized exposed scales. Pores on lower surfac of lower jaw in distinct clusters as in *P. alisonae* (Fig 2). Predorsal scaled forward to above posterior margi of eye.

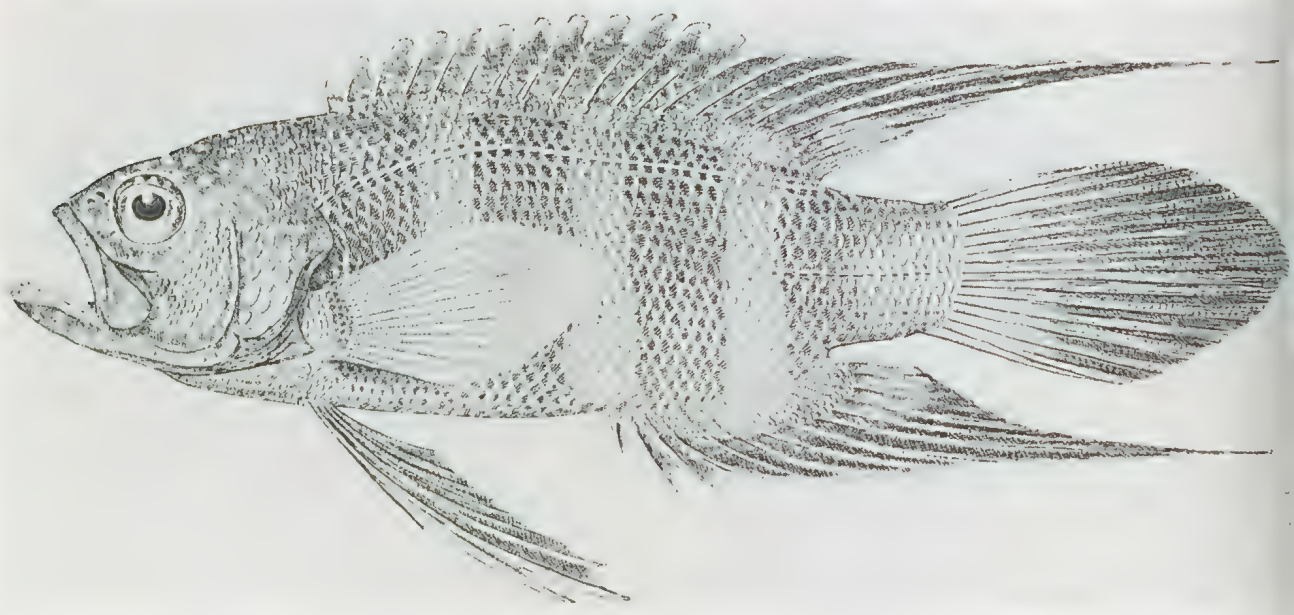

Fig. 4. *Paraplesiops bleekeri,* from Ogilby 1918.

Coloration in alcohol: Head and body tan to brown. Head with numerous small bluish-black, widely-spaced spots; spots much smaller than pupil diameter. No dark line above upper lip. Opercular spots subequal to cheek spots. Pelvic and median fins black, pectoral fin yellowish. Posterior end of dorsal and anal fins pale yellow. Caudal yellowish near base. Body with 4 broad dark brown bands, subequal to lighter interspaces.

Live coloration: Similar to preserved coloration, except as noted. Tips of median fins with a thin iridescent blue margin. Body bands black, interspaces white; bands and interspaces extending onto dorsal and anal fins. Posterior part of dorsal and anal fins yellow near base. Iridescent blue spots below and along bases of dorsal and anal fins. Pectoral fin yellow. Caudal fin bluish posteriorly, yellow near base. Caudal peduncle yellow from base of caudal to last black body band. Head spots iridescent blue. Outer margin of pelvic fin iridescent blue; rest of fin yellow, with blue along fin rays.

Juvenile coloration similar, but head spots larger; a large black spot covering posterior part of dorsal and anal fin; distal half of caudal fin black.

Günther (1861) indicated that the locality of the type was unknown, but thought that the specimen might have come from Norfolk Island. The species has not been found at Norfolk Island.

Material examined. *Queensland:* East of Palm Beach, Gold Coast—QM I.14875, 1(215). *New South Wales:* Woody Point—QM I.9899, 1(210). Newcastle —AMS IB.2621, 1(214); AMS IB.5459, 1(216); AMS IB.7541, 1(211). Terrigal—AMS IB.7540, 1(42). Austimer—AMS I.16533-001, 1(150). Avoca Beach, Sydney—AMS IB.7539, 1(157). Long Reef, Sydney—AMS I.15718-001, 1(204). Sydney area—AMS IB.7494, 1(224). Sydney Harbour—AMS A.704, 2(177-191); AMS I.12896, 1(212); AMS I.16720-002, 1(127); AMS I.16794-001, 1(151); AMS I.17272-001, 1(181). Port Hacking—AMS IB.822, 1(204); AMS I.14570, 1(202). Botany Bay—AMS I.9620, 1(200).

Fig. 5. Camera lucida drawing of lower surface of head of *Paraplesiops meleagris*, showing exposed preopercular scales.

Fig. 6. Camera lucida drawing of lower surface of head of *Paraplesiops meleagris*, showing arrangement of head pores.

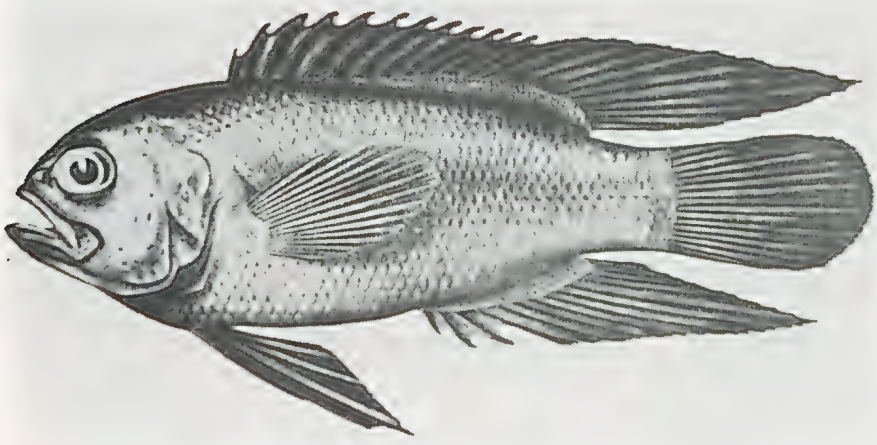

Fig. 7. *Paraplesiops meleagris*, after Waite.

Paraplesiops meleagris

Figs 5–7

Plesiops meleagris Peters, 1869: 708 (Adelaide, South Australia).
Bleeckeria catafracta Castelnau, 1873a: 14 (Victoria).
Ruppelia prolongata Castelnau, 1873b: 51 (Victoria).
Plesiops gigas Steindachner, 1884: 1089 (Gulf of St. Vincent, South Australia).

Diagnosis. Dorsal rays XI-XII, 9–10 (rarely XI or 9). Anal rays III, 9–11 (rarely 9 or 11). Other meristics shown in Tables 2–9. Pelvic fin very elongate, 34.2–45.4% of SL, reaching to between sixth to ninth anal ray. Caudal fin elongate, 29.2–44.3% of SL. Soft dorsal very elongate in adult, longest ray 27–56.6% of SL. Body deep, depth at pelvic origin 34–43.3% of SL. Preopercular margin smooth. Preopercular scales largely embedded, exposed in 2–7 vertical rows (Fig. 5); preoperculum densely covered with pores. Predorsal scaled forward to above or just behind posterior end of eye. Pores on lower surface of lower jaw dense and evenly spaced (Fig. 6).

Coloration in alcohol: Head and body brown to black. Head covered with numerous bluish-black spots, much smaller than pupil diameter. An enlarged spot on ventral part of operculum subequal to pupil. Body often with numerous longitudinal rows of black spots. Base of pectoral fin often with an irregular black blotch or bar dorsally. Pectoral clear to dusky. Other fins black.

Live coloration: Head, body and fins (except pectoral) dark blue to black, covered with numerous small iridescent blue spots, which form longitudinal rows on body. Distal margins of dorsal and anal fins with a thin iridescent blue stripe. Caudal margin edged with thin iridescent blue line. Thin iridescent blue stripe along outer margin of pelvic spine. Juveniles similar in coloration to *Paraplesiops bleekeri*.

Remarks. Type material was not examined. *Plesiops gigas* was described as having scales on the bases of the dorsal and anal fins, 21 lower lateral line scales, and elongate dorsal and anal fins, characteristic of *Paraplesiops meleagris*. *Ruppelia prolongata* and *Bleeckeria catafracta* were based on a single skin. Castelnau (1873b) regarded *Bleeckeria* as a lapsus calami, apparently intending to use the name for an anthiine later described as *Lacepedia*. The description is brief, with the specimen having elongate dorsal and anal fins, uniform colour and being 13 inches in total length, suggesting *Paraplesiops meleagris*.

Victorian specimens of *P. meleagris* show several differences from other populations (Tables 4, 5, 6 and 9). Multiple comparisons of populations using Analysis of Variance techniques (Scheffé, 1959) indicate that the Victorian population differs significantly ($p<.01$) from South Australian and Western Australian populations in having greater lower lateral line scale counts, longitudinal scale counts, and upper lateral line scale counts. Gill raker counts are significantly higher ($p<.01$) in specimens from Victoria than the counts from Western Australian specimens.

Material examined. *Victoria:* NMV A.17, 1(210). The Rip, entrance to Port Phillip Bay—AMS I.23895-001, 3(59-113). Portsea—AMS I.19775-001, 1(167). Queenscliff—NMV A.506, 1(225); NMV A.507, 2(187-214). *South Australia:* SAM F.2946, 1(85); F.1220, 3(185-197); F.1744, 1(205); 1745, 1(200). Brighton—SAM F.444, 1(233); F.343, 1(215). Balgowan, Spencer Gulf—SAM F.2847, 1(210). St Vincents Gulf—SAM F.1773, 1(198); F.1006, 1(245). Port Pirie— SAM F.75, 1(191). *Western Australia:* AMS I.11182, 1(170). Recherche Archipelago—WAM P.25774-001, 2(141-193). Lancelin I.—WAM P.4178, 1(88). Albany District—AMS I.12041, 1(225). Geographe Bay—AMS I.19629-019, 2(197-208). Fremantle—AMS I.13155, 1(93). Perth—SAM F.2872, 1(188). Rottnest I.—CSIRO C.2353, 1(169). Abrolhos I.—WAM P.385, 1(107).

Paraplesiops poweri

Figs 8 & 9

Paraplesiops poweri Ogilby, 1908: 17 (Mud Island, Moreton Bay, Queensland).
Paraplesiops joliffei Ogilby, 1916: 112 (Green Island, Moreton Bay, Queensland).

Diagnosis. Dorsal rays XII, 9–10 (rarely 9). Anal rays III, 10. Other meristics shown in Tables 2–9. Pelvic fin very elongate, 38.4–50.6% of SL, reaching posteriorly to between seventh to tenth anal ray. Caudal fin elongate, 35.3–38.9% of SL. Soft dorsal rays very elongate in adults, longest ray 29.3–43.1% of SL. Body deep, depth at pelvic origin 35.6–44.4% of SL. Preopercular margin denticulate. Preoperculum covered with numerous small close-set pores. On preoperculum a vertical row 1 or 2 scales wide from behind upper part of eye ventrally to behind posterior margin of jaws (Fig. 8); posterior margin of preoperculum naked, with numerous pores; rest of cheek with medium-sized embedded cycloid scales, visible only upon dissection. Pores on lower surface of lower jaw evenly spaced as in *P. meleagris* (Fig. 6). Top of head scaled to above posterior end of eye.

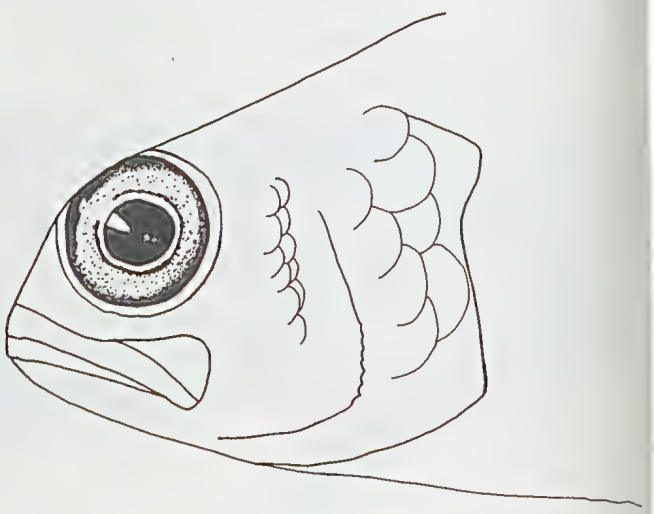

Fig. 8. Camera lucida drawing of head of *Paraplesiops poweri* showing exposed preopercular scales.

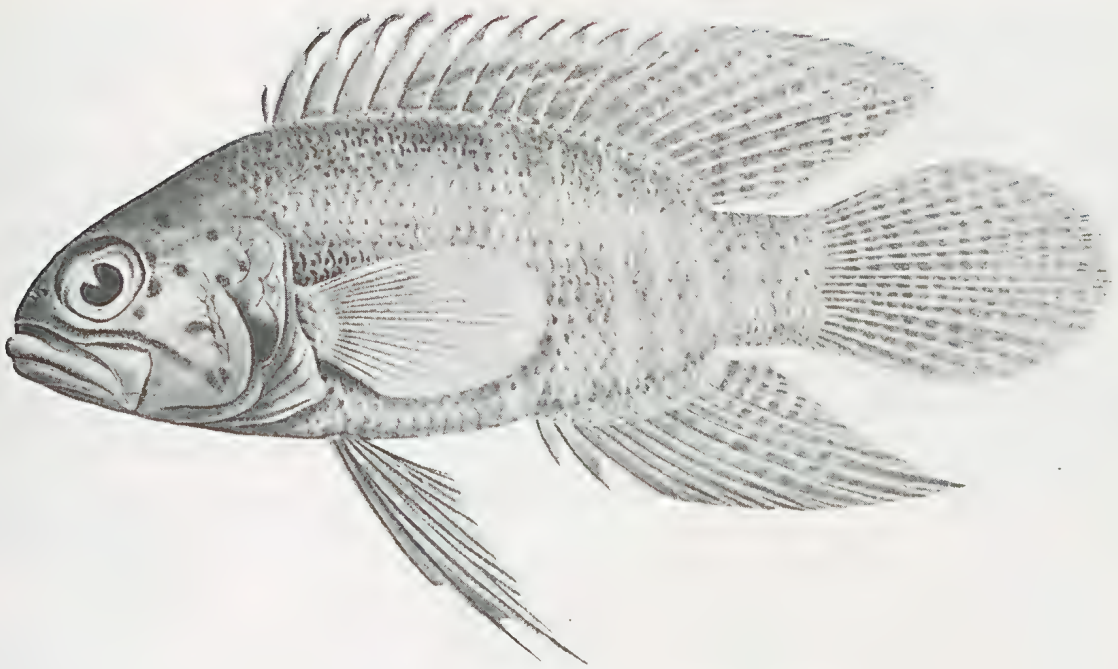

Fig. 9. *Paraplesiops poweri,* drawing of holotype of *P. jollifei,* from Ogilby, 1918.

Coloration in alcohol: Head and body dark brown. Head with several small widely-spaced black spots, much smaller than pupil diameter. Thin black line from below middle of eye above upper jaw, extending onto preoperculum towards, but not reaching, operculum. Large black spot about equal in size to pupil diameter ventrally on operculum. Pelvic and median fins black. Pectoral fins clear to dusky. Entire body with 8-10 narrow dark brown faint vertical bands; bands wider than interspaces.

Live coloration: Similar to preserved coloration, except as follows: Tips of dorsal spines blue. Body bands distinctly contrasting with lighter interspaces. Head spots and line bluish black.

Photographs have been examined of individuals from Tweed Heads, New South Wales.

Material examined. HOLOTYPE, QM I.1548, 1(125), Mud I., Moreton Bay, Queensland. Holotype of *Paraplesios jolliffei,* QM I.2652, 1(103), Green I., Moreton Bay, Queensland. Other material all from Queensland, arranged north to south: Bowen (Port Denison)—AMS IA.1785, 1(96); QM (unregistered), 2(90-100). Whitsunday Passage—AMS IA.858, 1(101); AMS IA.874-876, 3(84-97); AMS IA.879, 1(74). West Molle I.—QM I.5777-5778, 2(74-75). Lindeman I.—QMS IA.6687, 1(90). Great Keppel I. —AMS I.19347-002, 1(100). Humpy I.—AMS IB.7240, 1(38). Heron I.—AMS I.15482-010, 1(88); AMS I.15486-013, 1(67). One Tree I.—AMS I.15624-024, 3(75-82); AMS I. 15634-018, 1(90); AMS I.15641-029, 1(77); AMS I.15647-004, 3(73-90); AMS I.15647-044, 3(72-89); AMS I.15679-026, 2(95-104). Moreton Bay—AMS I.18258-001, 1(129); QM 541, 1(146); QM 2669, 1(85); QM 11609, 1(89). Moreton I.—QM 6744, 1(136).

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Table 2. Dorsal, anal and segmented caudal ray counts of *Paraplesiops* species.

Species	Dorsal spines		Dorsal soft rays		Anal soft rays			Branched caudal rays	
	11	12	9	10	9	10	11	15	16
P. poweri	—	25	2	23	—	25	—	24	—
P. bleekeri	1	17	—	18	1	17	—	10	—
P. meleagris	1	31	1	31	1	27	3	27	—
P. alisonae	9	2	2	9	1	9	1	7	1

Table 3. Pectoral ray counts in species of *Paraplesiops*.

Species		14	15	16	17	18	19	20	$\bar{x}$
P. poweri						1	23	1	19.0
P. bleekeri	left	1		1	9	7			17.1
	right		1		8	9			17.4
P. meleagris					6	27	1		18.4
P. alisonae					8	3			17.3

Table 4. Longitudinal scale count in species of *Paraplesiops*.

Species/Population		32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	$\bar{x}$
P. poweri		1	3	4	2	6	3	1															35.1
P. bleekeri									3	2	4	3	2	2	2								41.7
P. meleagris	Victoria															1		2	1	2		4	49.9
	S. Australia						1		1	1	1	2	2	4		1		1					42.6
	W. Australia										1	4	1	2		1							42.0
P. alisonae		1		2	1	1		2	1														35.8

Table 5. Upper lateral line scale counts in various species of *Paraplesiops*.

Species/Population	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	$\bar{x}$
P. poweri	2	3	8	9	3												30.3
P. bleekeri							5	4	6	2	1	1	1				35.9
P. meleagris Victoria										1	2	3	2		2	1	39.7
S. Australia							1	2	3	5			1				36.4
W. Australia								3	4	2	1						36.1
P. alisonae							5	2	1	2	1						35.2

Table 6. Lower lateral line scale counts in various species of *Paraplesiops*.

Species/Population	9	10	11	12	13	14	15	16	17	18	19	20	21	$\bar{x}$
P. poweri	1	1	16	5	1									10.3
P. bleekeri			1	8	8	3								12.7
P. meleagris Victoria								1	2	1	1	5	1	18.9
S. Australia					1		2	3	3		1	2		16.8
W. Australia				1			1	2	3	1	1	1		16.7
P. alisonae				1		5		5						14.7

Table 7. Predorsal scale count for species of *Paraplesiops*.

Species/Population	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	$\bar{x}$
P. poweri	1	7	7	4	3	3																			9.4
P. bleekeri														1	3	2	5	3		1		2	1		22.2
P. meleagris Victoria									1	2		2	1	1	1		1	2							19.4
S. Australia						1		1	1	2		1	3	2		1									17.5
W. Australia				1				1	1	1	1	1			2	1	1								17.3
P. alisonae									1	4		2		1											16.9

Table 8. Transverse scale counts and oblique cheek scale rows for species of *Paraplesiops*.

Species/Population	Transverse scale count—Anal origin to upper lateral line										Oblique cheek scale rows										
	13	14	15	16	17	18	19	20	21	22	2	3	4	5	6	7	8	9	10	11	12
P. poweri	7	8	6	2	—	—	—	—	—	—	17	6	1	—	1	—	—	—	—	—	—
P. bleekeri	—	—	—	—	3	9	3	3	—	—	—	—	—	—	—	—	2	4	5	7	—
P. meleagris Victoria	—	—	—	—	—	2	1	—	6	2	1	2	2	3	2	1	—	—	—	—	—
S. Australia	—	—	—	—	1	2	3	5	1	—	—	2	4	2	4	—	—	—	—	—	—
W. Australia	—	—	—	1	—	2	2	4	—	—	1	1	1	2	1	—	—	—	—	—	—
P. alisonae	—	1	4	3	1	—	—	—	—	—	—	—	—	—	—	—	—	2	4	1	1

Table 9. Lower gill raker counts for species of *Paraplesiops*.

Species/Population	9	10	11	12	13	14	15	$\bar{x}$
P. poweri	—	—	4	20	1	—	—	11.9
P. bleekeri	—	—	—	—	7	8	3	13.8
P. meleagris Victoria	—	—	—	—	4	6	1	13.7
S. Australia	—	—	—	4	2	4	—	13.0
W. Australia	—	—	2	6	1	1	—	12.1
P. alisonae	4	5	1	—	—	—	—	9.7

Table 10. Comparison of selected morphometric features in species of *Paraplesiops,* expressed as percentage of standard length.

Species	N	Size range (mm)	Longest dorsal ray	Pelvic length	Caudal length	Body depth at pelvic origin
P. poweri	25	38–129	29.3–43.1	38.4–50.6	35.3–38.9	35.6–44.4
P. bleekeri	18	127–224	39.5–51.9	39.4–48.9	32.6–40.5	32.6–38.9
P. meleagris	24	59–245	27.0–56.6	34.2–45.4	29.2–44.3	34.0–43.3
P. alisonae	8	56–115	21.7–25.4	26.4–33.8	23.2–28.4	26.4–32.2

Table 11. Measurements of types of *Paraplesiops alisonae* in mm. Second specimen, AMS I.19921-013, is holotype.

Character	AMS I. 19921-014	AMS I. 19921-013	AMS I. 20078-02	AMS I. 20089-003	AMS I. 20174-001	NMV A3145	NMV A3145	SAM F.4730
Standard length	115.0	106.0	92.5	56.2	101.0	106.0	34.4	105.0
Head length	38.0	36.0	32.5	21.0	39.0	36.3	13.1	36.0
Orbit length	8.2	7.7	7.2	4.9	8.7	7.7	3.9	8.0
Snout length	8.0	7.3	8.0	4.3	9.5	7.3	2.4	6.8
Jaw length	18.0	17.2	16.9	10.2	19.7	17.8	5.6	17.3
Suborbital width	2.4	2.5	2.4	1.3	2.6	5.6	1.7	5.6
Fleshy interorbital width	7.5	6.8	4.7	2.9	5.8	5.6	2.7	6.4
Body depth at pelvic origin	32.4	32.0	24.5	15.4	32.5	28.7	10.0	29.6
Pectoral length	31.0	27.8	22.8	14.2	28.4	29.5	9.6	26.0
Pelvic length	31.0	28.0	27.5	19.0	32.7	31.0	12.0	32.5
Caudal length	28.5	27.0	24.6	15.1	26.8	28.4	10.0	24.5
Longest dorsal ray	26.0	23.0	21.8	12.2	25.7	23.4	7.5	23.0

Millipedes from Australia, 6: Australiosomatini from Victoria (Diplopoda: Polydesmida: Paradoxosomatidae)

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ABSTRACT. Redescriptions of *Hoplatria clavigera* Verhoeff, 1941, and *Hoplatessara pugiona* Verhoeff, 1941. Descriptions of: *Somethus biramus* n.sp., characterized by the length of the tibiotarsal branch of the gonopods, and the small size of the femoral branch, which is reduced to a tiny lappet emanating from near the apex of the seminiferous branch; *Australiosoma laminatum* n.sp., characterized by the laminate expansion of the femoral process of the gonopods; and *Hoplatessara nigrocingulata* n.sp., particularly characterized by the relative length and shape of the femoral process of the gonopods. Two new genera are proposed: *Archicladosoma* and *Isocladosoma. Archicladosoma,* type species *A. magnum* n.sp., is of particular interest since it is characterized by what may be regarded as the most ancestral type of gonopods yet recorded in the Australiosomatini, with a distinctly demarcated femoral section, and the tibiotarsus, femoral process and solenomerite unmodified. *Isocladosoma,* type species *I. guttatum* n.sp., has the gonopods split into three branches, all of which emanate almost directly from the prefemur. The genus suggests *Cladethosoma* Chamberlin, 1920, but differs in having the femoral process elongate lanceolate, and in having only a single tibiotarsal branch, which in some species bears an additional spine. A second and third species, *I. pallidulum* n.sp. and *I. maculatum* n.sp., substantiate the characters of the genus. The three species are distinguished mainly by the structure of the tibiotarsus of the gonopods and by their colour pattern.

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Up to now, our information on the occurrence in Victoria of Paradoxosomatidae of the tribe Australiosomatini rested solely on a contribution by Verhoeff (1941), who described three species: *Hoplatessara pugiona* Verhoeff, from Whittlesea, and *Hoplatria clavigera* Verhoeff and *Cladethosoma forceps* (Verhoeff), both from 'Gippsland'.

The present paper, which is a sequal to a previous paper treating the Antichiropodini of Victoria (Jeekel, 1982a), is based primarily on material of the Australiosomatini collected by the author and his wife between 11 and 18 November 1980 in the coastal area of Victoria between Melbourne and the New South Wales border (Jeekel, 1981).

Important additional material was obtained on loan from the American Museum of Natural History, New York. Unfortunately, most of the samples in this collection were lacking data on locality, date and collector, the tubes containing only small labels with collection numbers. However, there can be little doubt that the material was obtained in Victoria by Ch. Barrett, probably somewhere to the east or north-east of Melbourne. Evidence for this is found in the facts that the collection contained material of *Hoplatria clavigera,* that it contained the type material of *Pogonosternum coniferum* Jeekel, 1965, and other samples of species of *Pogonosternum,* a genus now known to focus in eastern Victoria, and that the collection showed a certain coherence. Although the uncertainty with regard to the provenance of the material is much to be regretted, some species represented are taxonomically so important that it would be unwise to ignore their existence altogether. At least with regard to millipedes, Victoria is one of Australia's most undercollected areas, and under the circumstances all data on the composition of its fauna should be welcomed even when incomplete.

Finally, some incidental samples received on loan from the South Australian Museum, Adelaide, are also included.

The holotypes of the new species *Somethus biramus, Isocladosoma guttatum* and *I. pallidulum* will be deposited in the Australian Museum, Sydney.

Key to the Victorian Genera of the Tribe Australiosomatini (Based on Victorian Species only)

1. Acropodite of gonopods split deeply, almost to the base, into two main branches. Pattern of somites essentially transversely banded ..... *Somethus* Chamberlin

—— Acropodite of gonopods deeply split into three or four main branches 2

2. Acropodite consisting of three branches: solenomerite, femoral process and tibiotarsus 3

—— Acropodite consisting of four branches: solenomerite, femoral process and two tibiotarsal processes 6

3. Femoral section of gonopods distinctly demarcated by a constriction. Base of tibiotarsus situated quite distinctly distad of base of femoral process. Somites longitudinally banded ..... *Archicladosoma* n.gen.

—— Femoral section of gonopods indistinct, not demarcated by a constriction. Base of tibiotarsus about at same level as that of femoral process 4

4. Solenomerite with an additional preapical process containing a loop of the spermal channel. Somites almost unicolorous ..... *Australiosoma* Brölemann

—— Solenomerite without preapical process; spermal channel following an essentially straight course towards apex of solenomerite 5

5. Solenomerite exceeding both tibiotarsus and femoral process in length. Acropodite with undivided femoral section ..... *Hoplatria* Verhoeff

—— Femoral process overreaching apices of solenomerite and tibiotarsus. Acropodite without distinct femoral section: divided down to distal end of prefemur .. ..*Isocladosoma* n.gen.

6. Solenomerite apically trilobate. Femoral process distally laminate, apically rounded. Tibiotarsus consisting of two solid prongs, having towards their apex a typical undulate structure ..... *Hoplatessara* Verhoeff

—— Solenomerite apically rounded. Femoral process distally laminate, but ending apically in a somewhat recurved uncus. Tibiotarsus consisting of two lanceolate processes ..... *Cladethosoma* Chamberlin

Archicladosoma n.gen.

Diagnosis. Medium-sized Australiosomatini with 20 somites and a normal pore formula. Head with vertex transversely flattened in male, evenly convex in female. Antennae of moderate length, weakly clavate, antennomeres mostly subcylindrical, the 6th elongate obconical.

Somites rather weakly constricted. Waist rather narrow, rather weakly longitudinally ribbed. Metatergites smooth, hairless. Transverse furrow present from 5th somite onwards (faintly indicated on 4th), rather well impressed. Pleural keels weakly developed in male, a little more prominent in female, totally absent from 8th somite onwards.

Paranota weakly developed.

Sternites a little longer than wide in male, about as long as wide in female. Sternal cones weakly developed. Sternite of 5th somite with process between anterior legs. Legs rather long. First leg of male a little more incrassate and with ventral femoral tubercle. Tibial and tarsal scopulae present up to legs of 17th somite.

Gonopods with prefemur ovoid, its axis making a wide angle with axis of acropodite. Acropodite with distinctly demarcated femoral section, bearing on its latero-anterior side a long spinelike femoral process. Postfemoral section demarcated from femur by a distinct constriction. Tibiotarsus and solenomerite well developed; tibiotarsus a curved spine, solenomerite a solid process tapering towards apex. Spermal channel running along medioanterior side of acropodite, straight towards apex of solenomerite.

Type-species. *Archicladosoma magnum* n.sp.

Remarks. The discovery of this genus is of considerable importance to the evaluation of the phylogenetic significance of various gonopod characters in the Australiosomatini. *Archicladosoma* seems to represent a primitive type of gonopods, as is indicated by the fact that the femur is distinctly demarcated distally from the postfemur, and that the base of the femoral process is situated much more proximally than the tibiotarsus. A somewhat similar condition is found only in *Gigantowales* Verhoeff, 1937, in which,

however, the postfemur is strongly reduced and the tibiotarsus consists of two separate elongate spiniform processes. In all other Australiosomatini the tibiotarsus arises from about the same level as the femoral process, or even much closer to the base of the acropodite, in which case solenomerite and femoral process appear to be coalesced over some distance.

It seems obvious that in its gonopods *Archicladosoma* approaches the ancestral type from which the Australiosomatine genera descended. The genus will play an important role in the eventual phylogenetic analysis of the tribe.

The discovery of the genus substantiates the previously observed phenomenon (Jeekel, 1981:46) that within the entire range of the Australiosomatini the Queensland representatives are characterized by having the most derivative types of gonopods, whereas the genera with a more simple gonopod structure are found only in the south-eastern part of the Australian mainland.

Archicladosoma magnum n.sp.

Material. Australia, without locality (a 6042), ♂ holotype, 1 ♀ paratype (American Museum of Natural History, New York).

Description. *Colour*: Head dark castaneous in upper and lateral parts, frontal and clypeal areas paler, yellowish brown. Antennae dark castaneous; antennomeres distally annulate with yellow; 6th and 7th antennomeres particularly infuscate but tip whitish. Collum dark castaneous, with a broad median yellowish brown band, scarcely widening caudad. In the posterior half, median band bisected by a faint dark median line. Lateral margin of collum pale brownish. Somites dorsally dark castaneous, prosomites a shade paler, with two rather broad paramedian yellowish bands, in total a little wider than half width of metasomites, separated by a narrow dark median line. Yellow bands almost parallel-sided. Lateral and ventral part of somites, ventrad of upper level of paranota, yellowish brown, darker only along posterior margin of lateral sides. Sternites and legs yellowish brown. Anal somite dorsally yellowish, including entire epiproct, laterally dark castaneous. Paraprocts castaneous, lateral margins paler; hypoproct yellowish brown.

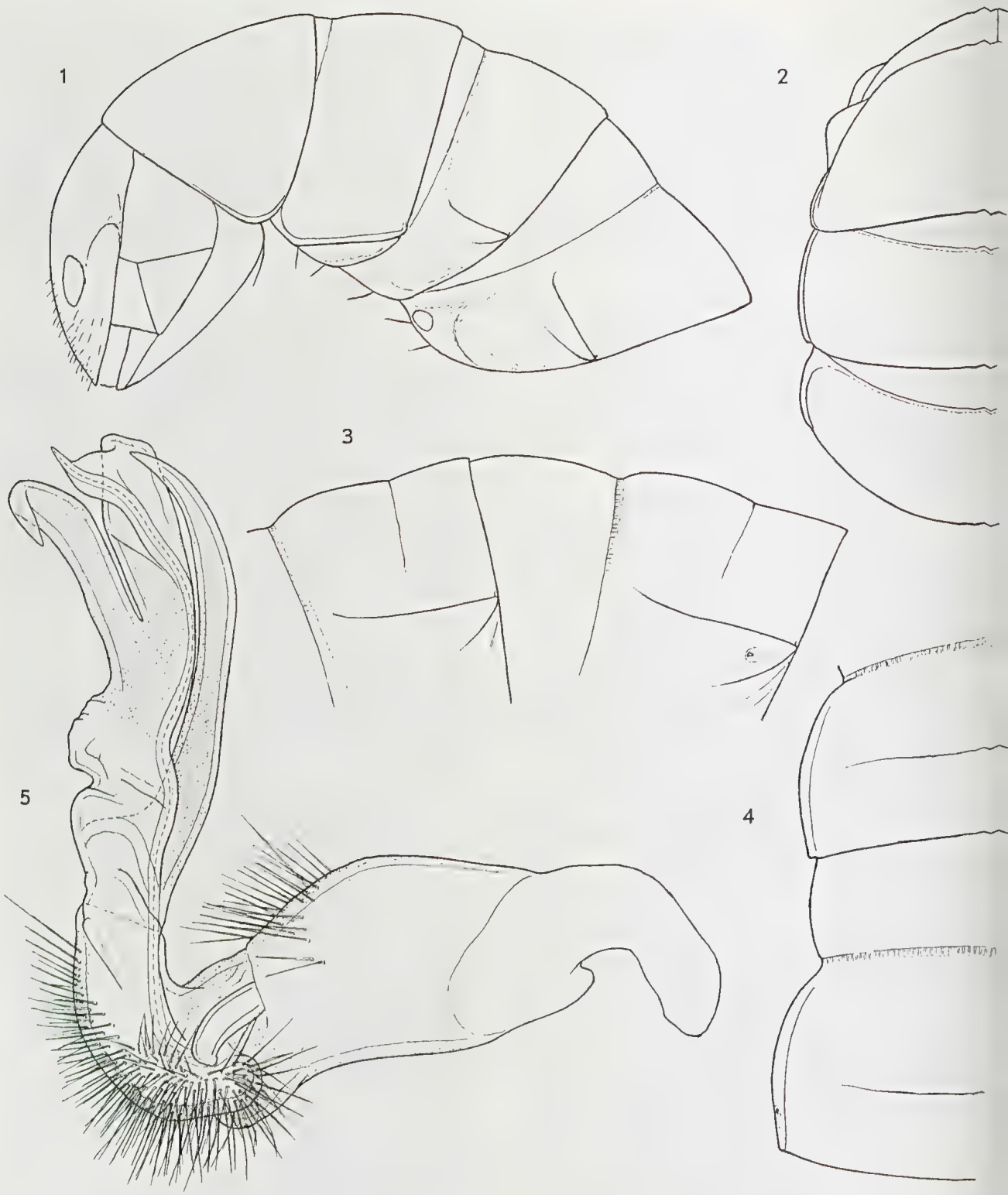
Width: ♂ 3.7 mm; ♀: 3.4 mm.

Head and antennae: Labrum moderately deeply and rather narrowly emarginate. Clypeus weakly convex, moderately but widely impressed towards labrum; lateral margin about straight, with a rather weak notch near labrum. Headplate rather coarsely rugulose up to middle of frontal area, upper part of frontal area more smooth, rather shiny, with some fine wrinkles. Pubescence rather dense in clypeus to moderate in frontal region; lateral sclerites almost hairless; vertex hairless. Setae of moderate length. Antennal sockets separated by 1.25 times the diameter of a socket or by 0.65 times length of 2nd antennomere. Postantennal groove of moderate depth and width; wall in front moderately prominent. Postantennal bean-shaped area distinctly demarcated and somewhat inflated. Vertex not demarcated from frons, transversely faintly convex in middle, a little more convex laterally; vertex longitudinally weakly and almost evenly convex. Vertigial sulcus moderately impressed, with fine transverse wrinkles, reaching scarcely below upper level of antennal sockets. Antennae of moderate length, moderately slender, weakly clavate. 2nd to 5th antennomeres subcylindrical, each widening a little distad, 6th elongate obconical. Relative length of antennomeres 2 to 6: 0.90, 1.00, 0.85, 0.85, 0.80. Pubescence moderate in proximal antennomeres, becoming dense in distal ones.

Collum (Figs 1,2): As wide as head, subtrapezoidal in dorsal outline. Anterior margin straight in middle, weakly convex more laterally, and straight or scarcely concave towards sides. Posterior margin very weakly and widely emarginate in middle, faintly convex towards sides. Lateral margin rather narrowly and evenly rounded. Surface of collum rather shiny, faintly rugulose, hairless. Surface transversely weakly convex in middle, distinctly more convex towards sides, sides almost perpendicular; longitudinally weakly convex, slightly more so in posterior half. Marginal rim laterally narrow, weakly raised; premarginal furrow fading away towards middle of anterior border.

Somites: Constriction rather weak. Waist sharply demarcated from prosomites, rather narrow, dorsally rather weakly longitudinally ribbed, laterodorsally weakly striate down to level of paranota, and faintly striolate below that level. Prosomites dulled by fine cellular structure, dorsally also finely and irregularly wrinkled. Metatergites more shiny, weakly leathery-rugulose, hairless. Transverse furrow distinct on 5th to 17th somites, faintly indicated on 4th. Furrow rather well impressed, without apparent sculpture, disappearing laterally at a distance from dorsal delimitation of paranota equal to about dorsoventral width of a poriferous paranotum. Sides rather finely rugulose, especially underneath paranota; rather densely rugulose-granulose in somites 2 to 4. Pleural keels quite weakly developed. In 2nd to 4th somites a weak swelling dorsally demarcated by a faint furrow; in 5th to 7th somites only a swelling near posterior margin, caudally faintly demarcated.

Paranota (Figs 1–4): Second somite scarcely wider than collum, 3rd scarcely narrower than 2nd and about as wide as 4th. Paranota of 2nd somite without angular anterior edge: latero-anterior margin narrowly and evenly rounded, without lateral tooth. Lateral border widely and almost evenly rounded, scarcely diverging caudad. Caudal edge subangular, scarcely produced caudad. Posterior border almost obsolete. Paranota ridgelike, situated on a low level and scarcely visible from above. In lateral aspect straight and sloping a little cephalad. Marginal rim narrow, of even width. Paranota of 3rd and 4th somites with lateral margin widely convex, in 4th somite very weakly convex halfway. Posterior edges bluntly subangular and



Figs 1–5. *Archicladosoma magnum* n.gen., n.sp., holotype ♂. **1:** left side of head, collum and 2nd to 4th somites, lateral aspect; **2:** left side of head, collum and 2nd and 3rd somites, dorsal aspect; **3:** left side of 11th and 12th somites, lateral aspect; **4:** same, dorsal aspect; **5:** right gonopod, medial aspect.

caudally not produced. Posterior margin almost obsolete. Dorsal demarcation in lateral aspect almost straight, premarginal furrow turning rather abruptly upward near waist and at posterior margin of somite, paralleling it shortly. Paranota of 5th and subsequent somites weakly developed; lateral margins of poreless and poriferous paranota widely convex. Posterior edge subangular, narrowly rounded and caudally not produced. In 14th to 17th somites the caudal edge becomes a little more angular and faintly produced caudad, but not projecting behind margin of somites. Posterior border almost obsolete. In lateral aspect the upper margin of the paranota is straight or faintly concave in poreless somites, slightly convex in poriferous ones. Dorsal furrow anteriorly not reaching waist, posteriorly ending near caudal margin of somite, paralleling margin quite shortly. Paranota ventrally demarcated by a depression in posterior two-fifths of their length. Ventral demarcation converging convexly with dorsal demarcation, meeting it in an acute angle. Pores in a rather small oval pit, situated about halfway in between dorsal and ventral demarcations. Dorsoventral width of paranota moderate, the poreless about two thirds of width of the poriferous ones.

Sternites and legs: Sternites of middle somites a little longer than wide (ratio 1.15:1.00). Cross-impressions moderately developed; longitudinal impression rather wide, transverse more furrowlike. Sternal cones present on postgonopodial somites up to the 16th, weakly developed at posterior side of caudal coxae of each somite: a low rounded cone directed caudad and a little ventrad. Near anterior coxae of each somite the cones are only indicated. Pubescence of sternites rather dense, especially near margins of coxal sockets; setae of moderate length. Sternite of 4th somite rather broad, transversely rather widely concave; pubescence rather dense, setae longish. Sternite of 5th somite with a short and broad process between anterior coxae, about half as wide as long, and a little broader than distance between coxae. Anterior surface in profile faintly convex, process directed a little caudad and not projecting in front of sternite. Posterior margin widely concave. Sides of process very short, diverging distad. Apex very broadly triangular, its anterior side with transverse brush of short setae. Pubescence on caudal surface rather dense, setae longish. Behind process a faint transverse impression. Posterior half of sternite flattened, without median impression, sloping in caudal direction; pubescence moderate, with longish setae. Sternite of 6th somite flattened and not raised above level of metasomal ring, except a little quite near coxal sockets. Coxal sockets widely separated. No longitudinal or transverse impressions. Pubescence moderate to rather sparse, setae longish. Sternite of 7th somite without apparent pregonopodial ridge, caudal margin behind gonopod aperture with some sparse setae. Sternite of 8th somite scarcely modified, longitudinal impression wider than normal, anterior coxae a little more widely separated than posterior. Legs longish, moderately stout. Femora scarcely arched. Prefemora, especially in anterior part of body, incrassate and dorsally rather strongly convex. First pair of legs not much thicker than the following, femur with the usual strongly-developed ventral tubercle. Coxae of 2nd pair slightly medially produced. Coxae of legs of 6th somite not particularly elongate, but those of anterior pair medially with a short rounded cone. Relative length of podomeres 2 to 6 in legs of middle part of body: 0.65, 1.00, 0.60, 0.60, 0.70. Ventral pubescence on all podomeres rather dense, with setae of moderate length. Dorsal pubescence apparent only on tibiae and tarsi. Scopulae present on all legs except last two pairs.

Anal somite: Dorsal profile straight or faintly convex. Epiproct longish, moderately thick and moderately wide. Sides weakly concave, converging moderately strongly, a preapical narrowing not conspicuous. Apex rather narrowly truncate, weakly emarginate. Setae not on tubercles. Paraprocts with moderately wide and rather low rims. Setae not on tubercles. Hypoproct broad, triangular to ogival, with sides weakly rounded, and apex more strongly rounded. Setae not on tubercles.

Gonopods (Fig. 5): Coxa of moderate size, tapering slightly towards apex. Prefemur elongate-ovoid, its distal lateral demarcation almost transverse on axis of telopodite. Femoral section short, distally demarcated by a distinct constriction. Femoral process strongly developed, arising from latero-anterior side of femur, gradually tapering towards end. Postfemoral section relatively strongly developed, protruding at base somewhat in medio-caudal direction. Tibiotarsus a simple, slightly curved lanceolate process, tapering towards apex. Solenomerite strongly developed, its apex acuminate. Spermal channel running along medio-anterior side of telopodite.

Female: Antennae separated by 1.3 times diameter of a socket or by 0.65 times length of 2nd antennomere. Vertex transversely evenly convex, longitudinally rather convex. Relative length of antennomeres 2 to 6: 0.90, 1.00, 0.90,0.90, 0.80. Collum transversely almost evenly convex, in the middle faintly flattened. Somites with pleural keels in 4th somite more prominent than in male; dorsal furrow quite concave and anteriorly prolonged in dorsal direction. Sternites about as long as wide. Cross-impressions weakly developed, no sternal cones. Pubescence rather sparse, setae of moderate length. Legs much more slender than in male. Pubescence sparse in proximal podomeres, to moderate in distal ones. Relative length of podomeres 2 to 6 in middle part of body; 0.60, 1.00, 0.45, 0.45, 0.85. Coxae of 2nd leg not medio-distally produced; at posterior side a quite low bluntly conical process pointing in a slightly medial direction. Ventral side of 3rd somite without particular sculpture; anteriorly with a very weak, blunt median cone, pointing cephalad, separating two quite wide paramedian emarginations; lateral edge of emarginations not produced cephalad.

Remarks. Material of this or a closely related species was collected at Sta. 93, Ferntree Gully Nat.

Park, 18 km ENE Dandenong, 18.xi.1980 (along nature track in temperate rainforest with tree-ferns, under logs and litter and in rotting trees), leg. C.A.W. Jeekel & A.M. Jeekel, 2♀.

The colour of these specimens is brighter than of the type specimens, obviously due to their more recent preservation. Head dark, almost blackish brown, somewhat paler in clypeal and labral areas. A paler spot at posterior side of antennal sockets. Antennae brown, with intersegmental membranes brownish; distal half of 5th, 6th and 7th antennomeres infuscate; tip whitish. Collum blackish brown, with a median yellowish band, widening slightly in caudal direction and about half width of collum at posterior margin. Lateral margin of collum narrowly yellowish. Somites also blackish brown; median yellowish band a little wider than half the width of the metasomites, faintly constricted at waist. Poreless paranota entirely, poriferous paranota in their posterior half yellowish. Sides brown, fading to pale brown towards venter. Venter, sternites and three proximal podomeres yellowish brown; three distal podomeres infuscate, tip of tarsi pale. Median band medially bisected by a dark stripe which is not pigmented brown but owes its colour to translucency in the absence of pigment. Anal somite with epiproct and the part in front of it entirely yellowish; rest blackish brown, fading to pale brown. Paraprocts rather dark brown without distinct paler margins; hypoproct pale brownish.

Width 3.3 and 3.5 mm. Morphologically these specimens agree entirely with the female paratype, except that the coxae of the 2nd pair of legs are slightly incrassate, but lack a conical production on their posterior side. Anterior margin of 3rd somite ventrally rather narrowly emarginate, with a distinct but low triangular median tooth produced cephalad.

Since the extent of variation in the epigynal structure of the species is unknown little can be said on the taxonomic status of these two specimens.

Hoplatria Verhoeff

Hoplatria Verhoeff, 1941: 13.—Jeekel, 1968:24.

Remarks. This monotypic genus is characterized by having the acropodite of the gonopods deeply split into three main branches as in the foregoing genus, but distinct in having the tibiotarsus emanating from about the same level as the femoral process, its base being closer to the base of the acropodite than in *Archicladosoma*. Moreover, a distinct constriction marking the distal end of the femur is lacking.

Hoplatria is certainly closely related to *Australiosoma* Brölemann, 1913, as indicated by the position of the femoral process and the tibiotarsus; even the curve of the tibiotarsus suggests the condition seen in *Australiosoma*. It is separated on account of the absence of an additional process of the solenomerite containing a loop of the spermal channel, and furthermore by the solenomerite's projecting well distad of the femoral process.

Homologization of the gonopod branches by Verhoeff was incorrect: his tibiotarsus is actually the femoral process, the true tibiotarsus was named by him '*Parsolaenomerit*'.

Hoplatria clavigera Verhoeff

Hoplatria clavigera Verhoeff, 1941: 13, figs 5, 6.

Previous record. Gippsland.

Material. Australia, without locality (A 5763, 45§5 (b)), 2 ♂ (American Museum of Natural History, New York).

Description. *Colour*: Head, including lateral sclerites dark brown, pale brownish around antennal sockets, particularly the bean-shaped area, and in labral area. Antennae also dark brown, without apparent annulation, tips whitish. Collum dark brown, anterior margin paler, lateral margin yellowish. Somites dorsally dark brown, paranota entirely yellowish. Lateral sides, venter and sternites and proximal podomeres pale brown, distal podomeres dark brown. Anal somite and paraprocts dark brown, epiproct dorsally and ventrally yellow and hypoproct yellow. Margins of paraprocts pale brownish. Posterior margin of somites slightly paler.

Width: 3.4–3.5 mm.

Head and antennae: Labrum rather widely and weakly emarginate. Clypeus rather weakly convex, but strongly impressed towards labrum. Lateral margins widely rounded, with a weak notch near labrum. Surface of headplate rather coarsely punctate and rugulose in clypeal and frontal parts, otherwise smooth and shiny. Pubescence rather dense in clypeal, moderate in frontal region, vertex hairless. Lateral parts sparsely pubescent. Hairs of moderate length to longish. Antennal sockets separated by 1.3 times diameter of a socket or by 0.7 times length of 2nd antennomere. Postantennal groove rather deep, and moderately wide, wall in front rather strongly prominent. Bean-shaped postantennal area distinctly demarcated and a little inflated. Vertex transversely faintly concave in middle, laterally moderately convex, with a faint lateral swelling; longitudinally evenly and widely convex. Sulcus moderately impressed, in particular halfway, reaching downward to upper level of antennal sockets; with some fine transverse wrinkles. Antennae rather long and stoutish, a little clavate; antennomeres 2 to 4 subcylindrical, widening somewhat distad, 5th and 6th more oblong-obconical. Relative length of antennomeres 2 to 6: 0.95, 1.00, 1.00, 0.90, 0.75. Pubescence rather dense in proximal antennomeres to dense in distal ones.

Collum (Figs 6–7): Subtrapezoidal in dorsal outline, a little wider than head. Anterior border straight in middle, widely and weakly rounded more laterally, and again straight towards sides. Posterior border widely

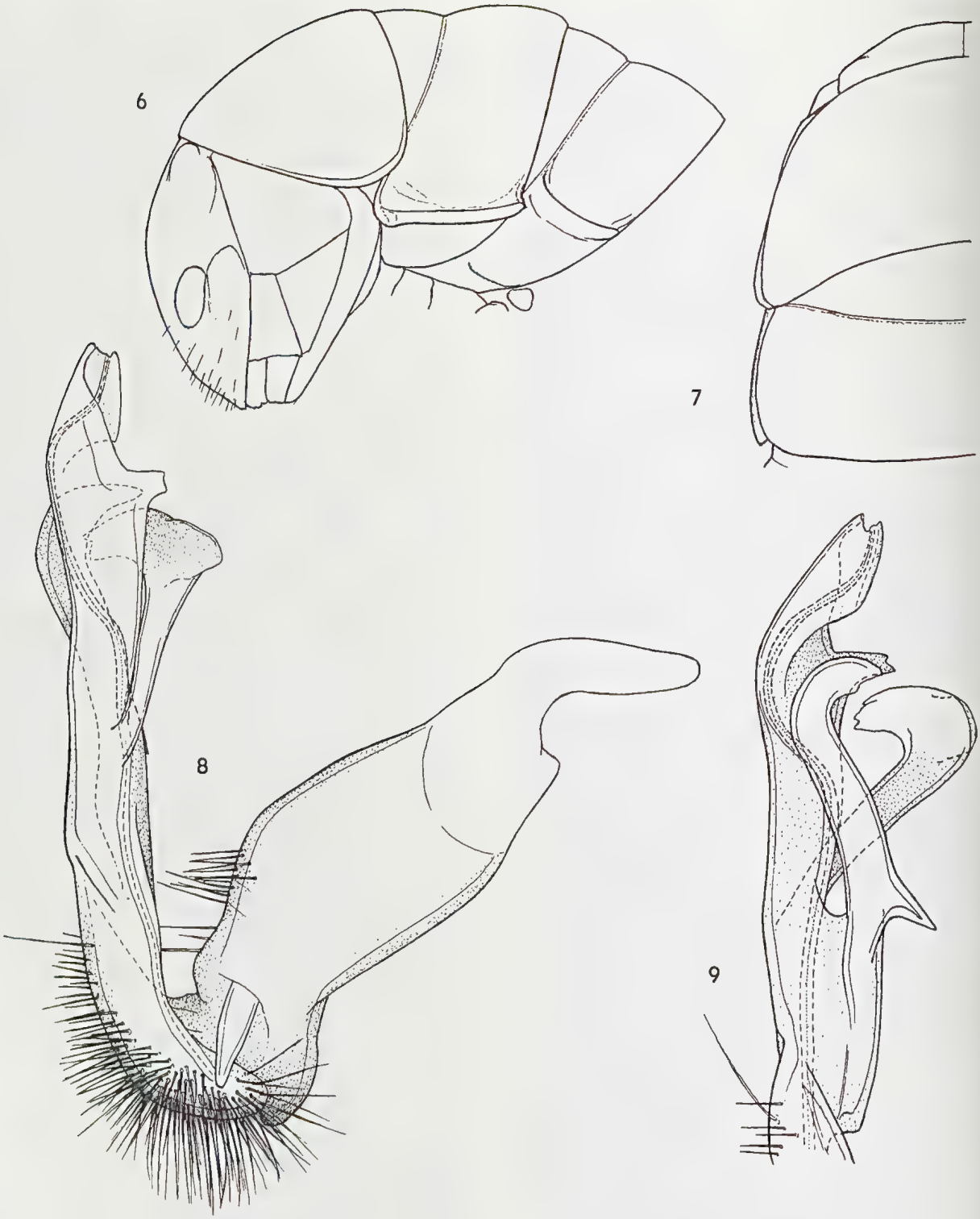
and weakly emarginate in middle, straight laterally. Lateral margin evenly and rather widely rounded. Surface of collum shiny, with some fine irregular wrinkles, hairless; transversely faintly convex in middle, more strongly convex towards sides, sides almost perpendicular; longitudinally widely and almost evenly convex. Marginal rim laterally rather narrow, rather weakly raised, premarginal furrow gradually fading away towards middle of anterior border.

Somites: Constriction rather weak; waist rather narrow, distinctly demarcated from prosomites. Waist dorsally striate, subcarinate, more laterally striate, and from level of paranota downward finely striolate. Prosomites very dull with a pronounced cellular structure, almost silky. Metatergites more shiny, with irregular wrinkles, hairless. Transverse sulcus well impressed, faintly sculptured, present from 5th to 17th somite, in middle somites separated from dorsal delimitation of paranota by about half the width of a poriferous paranotum. Sides mostly wrinkled, up to about 7th somite also finely granulate. Pleural keels represented in somites 2 to 5 by rather weak granulate ridges, dorsally faintly demarcated by a furrow. In the 6th and 7th somites developed especially near posterior margin as a small somewhat prominent rounded lappet, subangular, not produced. Pleural keels absent from 8th somite onwards.

Paranota (figs 6–7): 2nd somite faintly wider than collum; 3rd faintly wider than 2nd; 4th equal to 3rd. Paranota of 2nd somite with anterior border moderately convex, thrust forward a little. Latero-anterior edge rather wide, subangular, with a faint tooth. Lateral border widely convex, most convex in caudal half, diverging slightly caudad. Posterior edge acutely angular, caudally produced and projecting a little behind margin of somite. Posterior border short, about straight. In lateral aspect paranota situated on a low level, but lateral margin visible from above. Margin of paranota of moderate, even width, sloping a little cephalad, straight, with posterior end faintly turned upwards. Premarginal furrow posteriorly shortly paralleling posterior margin of somite. Paranota of 3rd and 4th somites subsimilar, widely and almost evenly convex, in 4th a little less convex. Posterior edge about rectangular, quite narrowly rounded, and weakly produced caudad, in 3rd somite projecting faintly behind margin of somite, in 4th not at all. Upper demarcation of paranota concave, anteriorly turning upward gradually towards waist, and posteriorly abruptly upward and paralleling posterior margin of somite shortly. Ventral demarcation present over two-thirds of length of paranota; paranota of 4th somite a little thicker than those of 3rd somite. Paranota of 5th and subsequent somites rather weakly developed. Lateral border weakly convex, anteriorly and posteriorly a little more convex. Posterior edge widely subangular, narrowly rounded, scarcely produced caudad in anterior somites, a little more so from 15th somite onwards and faintly projecting behind caudal margin in 17th and 18th somites. Dorsal demarcation in lateral aspect straight or faintly concave in poreless paranota, faintly convex in poriferous ones, turning upward anteriorly rather abruptly near waist, but not reaching waist. Premarginal furrow caudally curving abuptly upwards, and paralleling posterior margin of somite over a small distance. Ventral demarcation by a depression visible in posterior half of paranota only, converging convexly and meeting upper demarcation in an acute angle. Dorsoventral diameter of paranota moderate, poreless somites about two-thirds of poriferous ones. Pores situated in a small pit, about halfway between dorsal and ventral demarcations of paranota.

Sternites and legs: Sternites of middle somites longer than wide (ratio 1.25:1.00). Cross-impressions rather well developed, longitudinal impression rather wide, transverse one more furrowlike. No sternal cones. Pubescence arranged mainly in four quadrants, rather dense, with longish setae. Sternite of 4th somite rather wide, rather deeply transversely excavate. Pubescence rather dense with longish setae. Sternite of 5th somite with a subquadrate process between anterior coxae. Process a little narower than distance between coxal sockets, a little wider than long, its sides faintly converging distad, apex widely rounded. Anterior side in profile weakly convex, perpendicular, scarcely projecting in front of sternite. At apex a dense brush of short setae. Posterior side in profile weakly concave, moderately densely set with longish setae. Transverse furrow well impressed. Posterior half of sternite weakly transversely concave, not sloping caudad. Setae long. Sternite of 6th somite flattened but not down to level of ventral side of metasomal ring. No longitudinal furrow or impression. Between the anterior coxal sockets a low transverse wall, followed by a rather wide and moderately deep transverse impression. Between posterior coxae a weak transverse wall. Pubescence moderate, with long setae. Sternite of 7th somite with a weak, scarcely defined wall in front of gonopod aperture. Sternite of 8th somite anteriorly scarcely raised; the transverse impression weak; the posterior half with a wide median impression. Coxae of 6th somite and anterior coxae of 8th somite distinctly more widely separated. Legs of moderate length, rather stout, incrassate, with femora scarcely arched, prefemora dorsally rather strongly convex. Relative length of podomeres 2 to 6 in middle part of body: 0.65, 1.00, 0.55, 0.55, 0.70. Ventral pubescence of podomeres rather dense, with moderate to longish setae. Dorsal pubescence apparent in the four distal podomeres, sparser and setae shorter. Scopulae present up to legs of 16th somite, absent in those of 17th, thinning out gradually in legs of posterior half of body. First leg strongly incrassate, with a strong ventro-femoral tubercle. Coxa of 2nd leg without distal prominence. Coxae of legs of 6th somite scarcely elongate, medially faintly produced.

Anal somite: Upper profile widely and faintly convex. Epiproct longish, moderately thick, moderately wide. Sides widely converging concavely, nearly parallel at end. A faint stepwise narrowing near apex. Apex



Figs 6–9. *Hoplatria clavigera* Verhoeff, ♂. **6:** left side of head, collum and 2nd and 3rd somites, lateral aspect; **7:** left side of head, collum and 2nd somite, dorsal aspect; **8:** right gonopod, medial aspect; **9:** acropodite of left gonopod, caudal aspect.

rather narrowly truncate, faintly emarginate. Setae not on tubercles. Paraprocts with rims of moderate width and height. Setae not on tubercles or these abortive. Hypoproct broadly triangular, sides widely convex, end more narrowly rounded. Setae not on tubercles.

Gonopods (Figs 8, 9): Coxa longish, rather stout, tapering a little towards apex. Prefemur elongate-ovoid, almost in line with axis of acropodite; distal demarcation quite oblique. Femoral process relatively small, ribbonlike, somewhat sigmoidally curved, near its base

a spinelike process pointing laterad and proximad. Tibiotarsus narrow at base, widening distally, twisted around anterior side of solenomerite towards lateral and finally caudal side; its apex serrate. Solenomerite relatively strongly developed, laminate, with a slightly bifid lobe about halfway pointing cephalad; apex truncate and a little emarginate. Spermal channel running along medio-anterior side of acropodite.

Female: Unknown.

Remarks. The material at hand matches the description and drawings published by Verhoeff quite well. In the gonopods there is a slight difference: the small lobe of the solenomerite is illustrated by Verhoeff as simply acuminate, instead of bifid.

The present description was made to extend and supplement the rather brief diagnosis by Verhoeff.

Australiosoma Brölemann

Australiosoma Brölemann, 1913: 89.—Jeekel, 1968: 24; 1982b:137.

Remarks. This genus was briefly treated in a recent paper, where a key to its three described species was given, and its relationships discussed.

Australiosoma appears to focus geographically in south-eastern New South Wales. According to as yet unpublished data it extends northward into the New England area. The present record indicates that the genus crosses the NSW-Victorian border southward.

Australiosoma laminatum n.sp.

Material. Australia, without locality (A 5763, 4588d), ♂ holotype, 4 ♂ paratypes, 1 ♀ paratype, 6 juv. ♂ paratypes, 3 juv. ♀ paratypes. (American Museum of Natural History, New York).

Australia, without locality (A 5763, 4587), 3 ♂ paratypes, 1 ♀ paratype, 1 juv. ♂ paratype. (American Museum of Natural History, New York).

Description. *Colour*: Head and antennae dark castaneous; labral area, a ring around antennal sockets including bean-shaped postantennal area, and sutures of lateral sclerites brownish yellow. Tips of antennae whitish, annulation of antennomeres very vague. Collum dark castaneous, lateral margin scarcely paler. Somites dark castaneous, anterior part of prosomites and posterior part of metatergites a little paler. Paranota brownish yellow, especially in their posterior half. Venter, sternites and legs pale brownish, three distal podomeres somewhat infuscate. Anal somite dark castaneous; epiproct entirely yellowish. Paraprocts dark castaneous, lateral margins as well as hypoproct pale brown.

Width: ♂: 2.4–2.9 mm; ♀: 3.2 mm; juv. ♂ (19 somites): 1.8–2.3 mm; juv. ♀ (19 s.): 2.0 mm; juv. ♂ (18 s.): 1.4–2.1 mm; juv. ♀ (18 s.): 1.2–1.5 mm.

Head and antennae: Labrum moderately deeply and rather widely emarginate. Clypeus rather strongly impressed towards labrum; lateral margin faintly convex, with a rather weak notch above labrum. Pubescence of headplate with setae of moderate length or a little longish. Antennal sockets separated by 1.35 times the diameter of a socket or by 0.6 times length of 2nd antennomere. Postantennal bean-shaped area distinctly demarcated and somewhat inflated. Wall in front of postantennal groove moderately prominent. Vertex transversely faintly concave in the middle, rather convex laterally, but without lateral swelling. Vertigial sulcus weakly to moderately impressed. Relative length of antennomeres 2 to 6: 1.00, 0.95, 0.90, 0.85, 0.75. Pubescence of distal antennomeres dense, setae of moderate length.

Collum: Anterior border laterally faintly emarginate. Lateral border rather narrowly rounded. Surface of collum longitudinally evenly and widely convex, transversely weakly convex in middle, gradually more strongly convex towards sides; sides perpendicular or even faintly incurved. Marginal rim laterally rather narrow; premarginal furrow gradually disappearing towards level of lateral edge of vertex.

Somites: Waist of moderate width to narrowish, dorsally distinctly striate (not carinate), from level of paranota downward finely striaet. Prosomites dull, and with minute longitudinal striate. Transverse furrow of metatergites also indicated on 18th somite, in most tergites deeply impressed, with a sculpture of fine longitudinal striolae, reaching laterad to quite near (about half the diameter of a poreless paranotum) dorsal demarcation of paranota. Sides rather finely coriaceous, subgranulose, up to 4th somite minutely granular. Pleural keels up to 4th somite represented by weak granulate ridges, dorsally demarcated by a faint furrow; in 5th somite a weakly defined longitudinal swelling, gradually less developed on 6th and 7th somites and absent from 8th onwards.

Paranota: 2nd somite a little wider than collum; 3rd somite scarcely wider than 2nd, 4th a little wider than 3rd. Paranota of 2nd somite rather weakly prominent, on a rather low level, but lateral margin visible from above. Anterior border moderately convex, a little shouldered at base, but otherwise transverse on longitudinal axis. Lateral edge scarcely angular, narrowly rounded with a faint indication of a lateral tooth. Lateral border faintly convex, anteriorly and posteriorly a little more so, diverging a little caudad. Posterior edge slightly acutely angular, caudally produced and projecting a little behind margin of somite. Posterior border short, faintly concave. Margin in lateral aspect straight, weakly sloping cephalad, of even moderate width. Premarginal furrow anteriorly curving evenly and narrowly upward, posteriorly abruptly upward and paralleling posterior margin of somite over some distance. Paranota of 3rd and 4th somites widely convex, in 4th a little more convex anteriorly and posteriorly. Posterior edge in 3rd somite a little acutely angular, produced and projecting weakly behind margin of somite. In 4th somite posterior edge widely subangular and not caudally produced. Posterior margin short, scarcely concave in 3rd somite, about

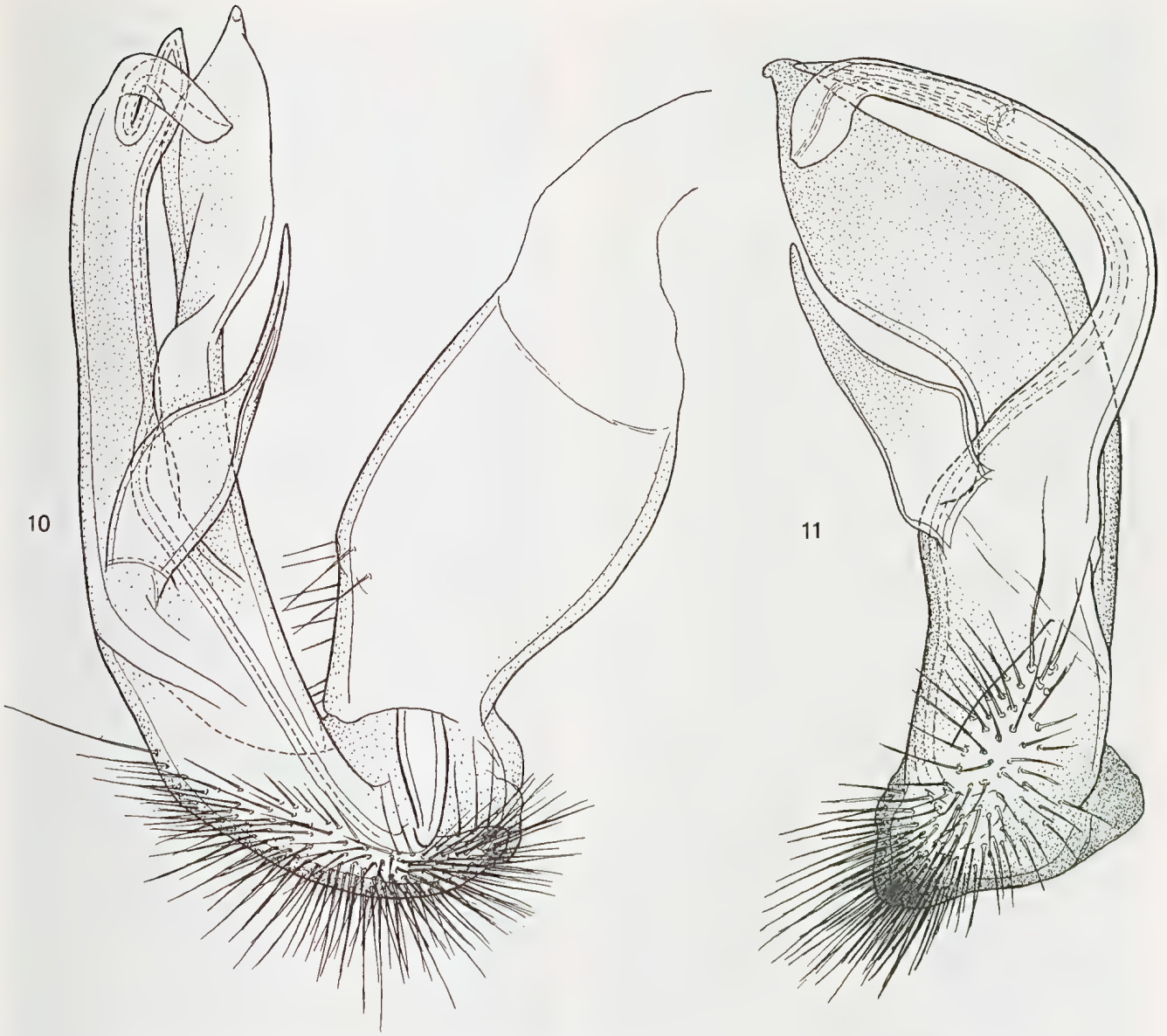
straight or a little convex in 4th. In lateral aspect dorsal demarcation about straight, sloping a little cephalad; premarginal furrow curving anteriorly rather abruptly upward in 3rd somite, more gradually so in 4th. Pósteriorly furrow curves abruptly upward, paralleling posterior margin of somite over quite some distance. Dorsoventral width of paranota of 3rd and 4th somites considerably wider than in 2nd somite, in particular in 4th somite. Paranota of 5th and subsequent somites weakly developed. Poreless paranota widely convex laterally, a little more strongly so at anterior end. Posterior edge subangular, narrowly rounded, faintly produced caudad except in 14th somite where more angular, weakly produced, but not projecting behind caudal margin of somite. Posterior margin short, about straight. Poriferous paranota a little more prominent, and a little more convex near caudal edge. Posterior edge widely subangular, narrowly rounded, becoming acutely angular in 16th and subsequent somites, projecting behind posterior margin of somite in 13th and 15th to 19th somites and especially in 17th and 18th. Paranota in lateral aspect with upper demarcation straight or a little concave in poreless, faintly convex in poriferous somites. Upper furrow ending anteriorly near waist, scarcely curving upward, and posteriorly curving abruptly upward, paralleling caudal margin of somite over a length of about one-third of distance between external margin of paranota and the median line. Dorsoventral width of paranota moderate, poriferous paranota about one-and-a-half times wider than the poreless. Ventral demarcation only present in posterior half of paranota, converging convexly towards dorsal demarcation and forming an acute angle. Angle a little wider in poriferous somites than in poreless ones. Ventral demarcation in poreless somites less convex than in poriferous ones. Pores situated quite near ventral demarcation, in a weakly impressed and relatively small pit.

Sternites and legs: Sternites of middle somites a little longer than wide (ratio 1.1:1.0). Cross-impressions moderately developed; longitudinal impression rather weak and wide, transverse deeper and more furrowlike. No sternal cones. Pubescence moderate, setae of moderate length. Sternite of 4th somite rather wide, widely transversely concave. Pubescence moderate. Sternite of 5th somite with a subquadrate process between anterior legs; process about as long as wide or slightly shorter than wide, a little narrower than distance between coxae. Lateral edges narrowly rounded, apex rather weakly convex. Process directed downward and a little cephalad, projecting very slightly in front of sternite. Anterior surface in profile straight at base, convex distally; apex with a brush of short setae. Posterior side moderately widely concave, pubescence moderate with longish setae. Behind process a deep transverse furrow. Posterior half of sternite with transverse wall between coxal sockets, without median impression, rather densely set with long setae. Coxal sockets not particularly raised; coxa not prolonged. Sternite of 6th somite a little raised anteriorly and posteriorly, with a weak transverse impression. Anteriorly with no longitudinal impression, posteriorly with a median impression down to level of metasomal ring. Coxal sockets pressed aside a little, not particularly raised, coxae not elongate. Pubescence rather dense with long setae. Sternite of 7th somite with a narrow but rather distinct pregonopodial wall. Sternite of 8th somite weakly raised; anterior part flat, without longitudinal impression. Transverse impression faint. Posterior half very weakly transversely concave. Anterior coxae pressed aside a little. Setation moderate, with setae of moderate length. Legs of moderate length and thickness. Prefemora incrassate, but dorsally only moderately convex. Femora scarcely or not arched. Ventral pubescence moderate to rather dense, dorsal pubescence only apparent in tarsi, where moderately dense. Scopulae thinning out in posterior somites and present up to legs of 17th somite. First pair of legs incrassate, with a ventro-femoral tubercle. Coxae of 2nd pair of legs medially rounded, not distally produced. Relative length of podomeres 2 to 6 in middle somites: 0.70, 1.00, 0.60, 0.65, 0.70.

Anal somite: Dorsal profile faintly convex, anteriorly faintly impressed. Epiproct rather thick, of moderate length, rather wide. Sides weakly concave, converging moderately strongly. Near apex epiproct is slightly narrowed, sides becoming almost parallel. Apex straight-truncate, edges narrowly rounded. Setae not on tubercles. Paraprocts with setae not on tubercles. Hypoproct broad, semicircular, setae not on tubercles.

Gonopods (Figs 10,11): Coxa stout, tapering towards apex. Prefemur elongate-ovoid, almost in line with axis of acropodite; lateral distal demarcation quite oblique. Femoral process broadly laminate, apically acuminate. Tibiotarsus slightly sigmoidally curved in medial aspect, widening a little distad of base, but otherwise gradually tapering towards the pointed apex. Solenomerite strongly developed, curving widely mesad, bearing near the apex a strong spinelike process containing a loop of the spermal channel. Apex of solenomerite laminate, slightly expanded. Spermal channel running along medio-anterior side of acropodite.

Female: Clypeus moderately impressed. Vertex transversely moderately and evenly convex. Antennal sockets separated by 1.25 times diameter of a socket or by 0.6 times length of 2nd antennomere. Relative length of antennomeres 2 to 6: 1.00, 0.90, 0.90, 0.90, 0.80. Collum transversely widely convex, only slightly flattened in middle; sides perpendicular. Pleural keels distinct up to 4th somite, represented by raised crests with a posterior edge which in 3rd somite is slightly produced caudad. In 5th somite a swelling, not sharply demarcated. Pleural keels absent from 6th somite onwards. Sternites of middle somites broader than long (ratio 1.15:1.00). Cross-impressions weaker than in male; transverse impression distinct only between coxae of subsequent legs. Legs not incrassate, femora straight. Ventral pubescence of podomeres weaker than in male. Relative length of podomeres 2 to 6 in middle somites:



Figs 10 & 11. *Australiosoma laminatum* n.sp., holotype ♂. **10:** right gonopod, medial aspect; **11:** telopodite of left gonopod, caudal aspect.

0.75, 1.00, 0.55, 0.55, 0.75. Epigynal structure with ventral side of 3rd somite widely emarginate behind each coxa, lateral edge of emargination scarcely produced cephalad, the margin not raised, and ventral surface of 3rd somite without particular sculpture. Median tooth low, pointing cephalad. Coxa of 2nd leg swollen, with a rather long laterocaudal spinelike process pointing laterad.

Remarks. This species approaches *A. michaelseni* (Attems) in the absence of a pair of yellowish dorsal bands, but is distinct in being larger (width of ♂ of *A. michaelseni:* 1.5–1.7 mm). The two other species, *A. rainbowi* Brölemann and *A. clavigerum* (Verhoeff), are considerably larger: width of ♂ 4.0 mm or more. *A. clavigerum* has a three-pronged solenomerite, and both species differ from *A. laminatum* in having a rod-like and distally more or less truncate femoral process.

In characters not mentioned the description of *A. clavigerum* applies (Jeekel, 1982b).

Somethus Chamberlin

Somethus Chamberlin, 1920: 128.—Jeekel, 1968:27; 1979:651.

Remarks. The type species of this genus, *S. fuscipes* Chamberlin, 1920, was described from 'Australia' without specification of locality. It was redescribed by Jeekel (1979) but unfortunately the characters of the gonopods had to remain obscure. In the meantime, material of two species, one of which matching the

verbal description of the gonopods by Chamberlin quite well, was obtained in Tasmania (Jeekel, in preparation). Moreover, a species of *Somethus* was discovered among material from South Australia (Jeekel, in press), so that the taxonomic status of the genus can be regarded as sufficiently clarified.

Somethus biramus n.sp.

Material. Sta. 82, New South Wales, Boydtown, 5 km SSW Eden, 12.xi.1980 (rather wet eucalyptus forest, disturbed, under logs), 7 ♂ paratypes, 2 ♀ paratypes, 1 juv. ♀ paratype.

Sta. 84., Victoria, Drummer State Forest, 15 km E Cann River, 13.xi.1980 (eucalyptus forest along Princes Highway, under logs), 3 ♂ paratypes.

Sta. 85., Victoria, 13 km SE Buchan, 14.xi.1980 (eucalyptus forest, state forest, under logs), ♂ holotype, 3 ♂ paratypes, 4 ♀ paratypes.

Cave M49, Murrindal, 22 vii.1967, leg. A. Spate (BS 1608), 1 ♂, 1 ♀ paratypes (South Australian Museum, Adelaide).

The Basin, Slocomes Cave Ba1, 10.vii.1976, leg. A. Davey VSA, 1 ♂ paratype (South Australian Museum, Adelaide).

Description. *Colour*: Head dark brown; labral area, a ring around antennal sockets and sutures of lateral sclerites brownish yellow. Antennae brown, intersegmental membranes brownish yellow, tip whitish. Collum blackish brown, with a narrow yellow stripe along anterior margin and a similar stripe along posterior margin, widest medially and tapering towards sides. Somites blackish brown; posterior half of metatergites, posterior half of paranota, and a larger posterior part of sides brownish yellow. Medial part of prosomites, mostly concealed by anterior somite, with a rounded yellowish spot. Venter and sternites pale brownish. Legs dark brown, the ventral side a little paler; distal margins of podomeres and intersegmental membranes brownish yellow; tip of tarsi also brownish yellow. Anal somite dark brown; epiproct and narrow margins of ring yellow. Paraprocts brown with yellow margins. Hypoproct pale brownish.

Width: ♂: 2.5–3.2 mm; ♀: 2.7–3.4 mm, juv. ♀ (19 somites): 2.1 mm. The two specimens from the cave near Murrindal are larger than the other specimens (♂: 3.2 mm; ♀: 3.4 mm, against 2.9 and 3.0 respectively as a maximum value in the other samples).

Head and antennae: Labrum moderately deeply and rather widely emarginate. Clypeus moderately convex, strongly impressed towards labrum, surface somewhat rugulose and impressed punctate. Lateral border faintly convex, with a weak notch near labrum. Frons somewhat rugulose, pitted. Antennal sockets separated by 1.35 times diameter of a socket or by 0.65 times length of 2nd antennomere. Pubescence moderate in clypeus to sparse in frons and lateral sclerites; setae of moderate length. Postantennal beanshaped area obsolete, only some wrinkles. Postantennal groove of moderate width and depth; wall in front moderately prominent. Vertex smooth, shiny, transversely faintly concave in middle, laterally moderately convex, without swelling. Vertigial sulcus moderately impressed, down to upper level of sockets, with fine transverse wrinkles. Vertex hairless. Antennae longish, moderately stout. Antennomeres subcylindrical, each distally widening, 5th and 6th a little more obconical, weakly clavate. Pubescence rather weak in proximal antennomeres, to rather dense in distal ones. Relative length of antennomeres 2 to 6: 1.00, 0.95, 0.90, 0.85, 0.85.

Collum: As wide as head, subtrapezoidal in dorsal outline. Anterior border straight, more laterally widely rounded and straight again towards sides. Posterior border widely and weakly emarginate in middle, weakly convex more laterally, and straight with a weak but distinct notch towards sides. Lateral border rather widely and almost evenly rounded. Surface smooth or with some weak wrinkles, shiny, with some weak setae near anterior margin and some more in middle. Surface transversely faintly convex in middle, more strongly rounded laterally, sides almost perpendicular, longitudinally weakly and almost evenly convex. Marginal rim narrow, weakly raised. Premarginal furrow disappearing gradually towards middle of anterior border.

Somites: Constriction rather weak. Waist rather narrow to narrow, sharply demarcated from prosomites, distinctly striate-subcarinate to beaded dorsally, finely striate from level of paranota downward. Prosomites dulled by a fine cellular structure. Metatergites shiny, smooth or somewhat irregularly wrinkled, hairless or with a transverse row of up to six weak setae in front of transverse furrow. Transverse furrow present from 5th to 17th somite, faintly indicated also on 18th somite, moderately well impressed, with a fine sculpture, disappearing laterally at a distance about equal to diameter of a poreless paranotum. Sides rugulose, in anterior somites up to 7th especially in lower part also granulate. Pleural keels represented by crenulate ridges, dorsally demarcated by a curved furrow, ending in a weakly pronounced edge in 3rd somite. In 5th somite only a weak swelling, not demarcated, in 6th and 7th somites only a weak swelling above posterior legs.

Paranota: 2nd somite a little wider than collum; 3rd as wide as 2nd, and a little narrower than 4th. Paranota of 2nd somite weakly developed, ridgelike, sloping a little laterad, situated on a low level, but lateral border visible from above. Anterior border widely convex, transverse, not shouldered. Lateral edge widely angular, with a faint lateral tooth. Lateral border anteriorly vaguely convex, almost straight, posterior half more convex, scarcely diverging caudad. Posterior edge slightly acutely angular, produced distinctly caudad and projecting a little behind posterior margin of the somite. Posterior border rather short, slightly convex. Paranota in lateral aspect with marginal rim of moderate and about even width, straight and sloping faintly cephalad, posterior half curving gradually a little upward. Premarginal furrow anteriorly and posteriorly curving abruptly upward, posteriorly paralleling caudal margin

of somite shortly. Paranota of 3rd somite anteriorly rather widely, posteriorly more widely convex. Posterior edge about rectangular, weakly produced caudad, projecting faintly behind margin of somite. Posterior border straight, short. Dorsal demarcation in lateral aspect faintly concave; upper furrow curving abruptly upwards towards waist, posteriorly paralleling margin of somite shortly. Paranota of 4th somite similar to those of 3rd, but in dorsal aspect especially posteriorly less convex. In lateral aspect dorsal demarcation weakly concave, the furrow curving more gradually upward anteriorly. Ventral demarcation of paranota of 3rd and 4th somites present in posterior three-fifths; dorsoventral diameter moderate. Paranota of 5th and subsequent somites weakly developed. Lateral border weakly convex, anteriorly a little more strongly rounded, and in poriferous somites posteriorly also a little more convex. Posterior edge widely angular in 5th somite, acutely angular and weakly produced caudally from 6th somite onwards, and projecting faintly caudad of margin of somite from about 12th somite up to 18th. Posterior border short, about straight. In lateral aspect, dorsal demarcation weakly concave in poreless paranota and straight or faintly convex in poriferous ones. Upper furrow running anteriorly to near waist, anterior end curving briefly a little upward, posteriorly curving abruptly upward and paralleling posterior margin of somite shortly to scarcely. Ventral demarcation in poriferous paranota present in posterior half, in poreless paranota a little less, curving gradually upward and meeting upper demarcation in an acute angle. Ventral demarcation weakly convex and very similar in poriferous and poreless paranota. Dorsoventral width of paranota moderate, in poreless somites about two-thirds of that in poriferous somites. Pores rather large, situated in an oval pit about halfway between dorsal and ventral demarcations.

Sternites and legs: Sternites of middle somites longer than wide (ratio 1.35 : 1.00). Cross-impressions moderately developed, transverse and longitudinal impressions both rather wide, the transverse becoming furrowlike only between subsequent coxal sockets. No sternal cones. Pubescence moderate, concentrated especially on coxal sockets; setae on minute granules, of moderate length. Sternite of 4th somite wide, deeply transversely excavated, with median part about level with ventral side of metasomal ring. Pubescence moderate, setae longish. Sternite of 5th somite with a process arising between and a little in front of anterior coxal sockets. Process subquadrate to subparabolical, about as long as wide, and as wide as distance between coxal sockets. Sides converging distad a little, edges rounded, apex weakly convex. Process directed ventrad and a little cephalad, projecting distinctly in front of sternite. Anterior side in profile widely convex; apex with a brush of short setae. Posterior side straight at base, widely concave distally; pubescence sparse and setae unapparent. Transverse furrow deep. Posterior part with a median furrow, raised a little towards coxal sockets. Pubescence moderate, setae longish. Sternite of 6th somite with coxal sockets pressed aside a little, sockets not raised, coxae not elongate. Sternite flat, only a faintly raised wall between anterior coxae. Behind it a weak transverse impression. Posterior half less raised, but only a semicircular medio-caudal area is level with ventral side of the metasomal ring. Pubescence moderate, setae longish. Sternite of 7th somite with a rather weakly prominent, finely granular wall latero-cephalad of gonopod aperture. Coxae of ambulatory legs pressed aside a little. Sternite of 8th somite anteriorly flattened, without longitudinal impression, sloping a little cephalad down to ventral level of meteasomal ring. Transverse impression obsolete except between subsequent coxae. Posterior half of sternite with longitudinal impression a little wider, otherwise not modified. Anterior coxae a little more widely separated than posterior. Pubescence rather sparse to moderate. Legs of moderate length and thickness. Prefemora dorsally rather convex; femora scarcely arched. Ventral pubescence rather dense, with setae of moderate length to longish. Dorsal pubescence moderate on tarsi, otherwise unapparent. Scopulae present up to legs of about 15th somite, gradually thinning out in postgonopodial legs. Relative length of podomeres 2 to 6 in legs of middle somites: 0.65, 1.00, 0.60, 0.65, 0.70. First leg rather strongly incrassate, with a ventral femoral tubercle. Coxa of 2nd leg medially a little inflated, not distally produced.

Anal somite: Dorsal profile weakly and evenly convex. Epiproct rather thick, broad and of moderate length. Sides weakly concave, almost straight, converging weakly towards apex, without abrupt constriction near apex, but near apex a little convex. Apex broadly truncate, distinctly but not deeply emarginate, edges a little produced, narrowly rounded. Setae on abortive granules. Paraprocts with moderately high and wide rims, setae on weak granules. Hypoproct broadly subtriangular, sides almost straight or a little convex, apex moderately widely rounded. Setae not on tubercles.

Gonopods (Fig. 12): Coxa of moderate length, rather stout, apically provided with a number of rounded tubercles at medio-anterior side. Prefemur ovoid, its longitudinal axis making a wide angle with axis of acropodite; latero-distal demarcation quite oblique. Acropodite with a small but distinct undivided femoral section. Tibiotarsus long, rodlike, tapering at apex, which is curved slightly medio-caudad. Tibiotarsus nearly as long as seminiferous branch. The latter also strongly elongate, slender, bearing near its end a strongly reduced femoral process, and a conical process containing a loop of the spermal channel. End of solenomerite curving abruptly caudad and finally mesad, its apex finely tapering. Spermal channel running along medial side of acropodite, curving towards latero-caudal side before entering subterminal process.

Female: Clypeus longitudinally rather convex, rather strongly impressed towards labrum. Antennal sockets separated by 1.2 times diameter of a socket or

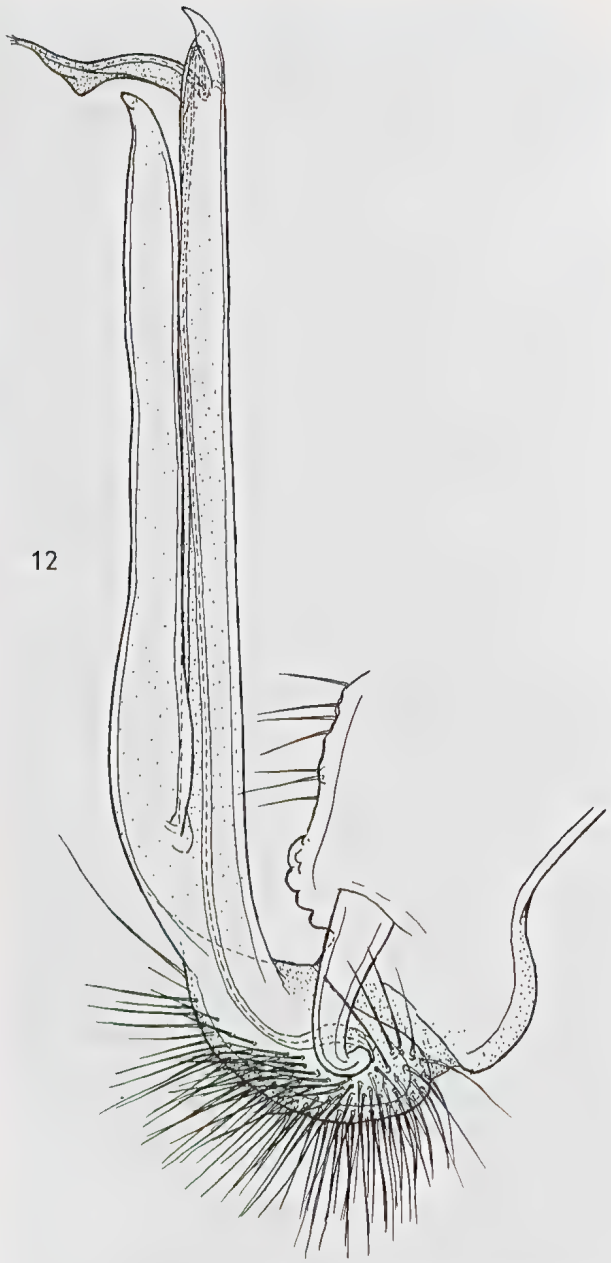


Fig 12. *Somethus biramus* n.sp., holotype ♂, right gonopod, medial aspect.

by 0.65 times length of 2nd antennomere. Vertex transversely evenly convex. Relative length of antennomeres 2 to 6: 1.00, 0.90, 0.80, 0.80, 0.80. Collum transversely almost evenly convex. Pleural keels up to 4th somite as in male, absent from 5th somite onwards. Sternites of middle somites as long as wide. Cross-impressions weakly developed, wide, furrowlike only between subsequent coxal sockets. Pubescence rather sparse. Legs not incrassate, femora straight. Relative length of podomeres 2 to 6 in middle somites: 0.75, 1.00, 0.55, 0.55, 0.80. Ventral pubescence less dense than in male. Coxa of 2nd leg medially and caudally callously inflated, but without process. Ventral side of 3rd somite with paramedian emarginations quite shallow, lateral edges not produced cephalad. Median point scarcely produced, but a small median crest or lobe projects downward. Surface without apparent sculpture.

Remarks. This species is well characterized in particular by the structure of the gonopods, in which the femoral process is strongly reduced, resulting in an essentially two-branched telopodite. The other known species have a considerably larger femoral process, which arises distinctly more proximally. The length and shape of the tibiotarsal branch are also quite characteristic.

Cladethosoma Chamberlin

Cladethosoma Chamberlin, 1920: 105.—Jeekel, 1979; 1982b: 141.
Leucotessara Verhoeff, 1928: 90, 92.—Jeekel, 1968: 24.
Walestessara Verhoeff, 1937: 137.

Remarks. This genus was briefly treated recently (Jeekel, 1982b), and a key to the species provided. Five species have been described from the central area of coastal New South Wales northward to Wallangra, the sixth belongs to the Victorian fauna and was recorded from Gippsland.

In the gonopods the genus shows much similarity with *Hoplatessara* in having the acropodite of the gonopods deeply split into four main branches: solenomerite, femoral process and two tibiotarsal prongs. It is distinguished by the apex of the solenomerite's being simply rounded, with the spermal channel near its end simply a little recurved and by the shape of the femoral process, which is either rodlike or laminate, generally ending in an uncate spine. The tibiotarsal branches are more or less folded lanceolate laminae instead of solid rods.

In the field the species are mostly distinguished by having a pair of light-coloured longitudinal bands, which in the Victorian species diverge caudad enclosing a dark triangle on each metasomite.

Cladethosoma forceps (Verhoeff)

Hoplatessara (Walestessara) forceps Verhoeff, 1941: 14, fig. 7.

Remarks. This species was described from Gippsland, without further data. It was not represented in the material covered here.

Isocladosoma n.gen.

Diagnosis. Rather small to medium-sized Australiosomatini with 20 somites and a normal pore formula. Head with vertex transversely flattened in male, almost evenly convex in female. Antennae of moderate length, stoutish, distinctly clavate; antennomeres subobconical to obconical.

Somites rather weakly to moderately constricted. Waist rather narrow, dorsally rather coarsely 'beaded'.

Metatergites smooth, hairless. Transverse furrow present from 5th somite onwards, well impressed. Pleural keels moderately developed up to 4th somite, weak or absent in a few subsequent somites, absent from 8th somite onwards.

Paranota rather weakly developed.

Sternites distinctly longer than wide in male, about as long as wide in female. No sternal cones. Sternite of 5th somite with a process between anterior legs. Legs of moderate length. First leg of male incrassate, with a distinct ventral femoral tubercle. Scopulae disappearing in middle third of the body.

Gonopods with coxa stoutish and short in relation to length of telopodite. Prefemur ovoid, rounded, its distal demarcation almost transverse on axis of telopodite; angle between prefemur and acropodite relatively narrow. Femoral section of acropodite vestigial; acropodite split to base into three main elements: solenomerite, femoral process and tibiotarsus. Femoral process arising from lateroanterior side of acropodite, consisting of a simple curved rod, tapering distally, apex acuminate and reaching a little distad of the other two elements of the acropodite. Solenomerite also of simple structure: widening a little towards middle, apex slightly spatulate. Spermal channel running straight towards apex of solenomerite, without loop. Tibiotarsus arising mesocaudad of acropodite, either rodlike and distally truncate, or more complex, with a distal expansion and the presence of a lateral spinelike process arising about halfway its length.

Type-species. *Isocladosoma guttatum* n.sp.

Remarks. This genus is unique among the Australiosomatini in the almost complete loss of the femorite of the gonopods, combined with the condition that the three main elements of the acropodite arise from almost the same level. This type of gonopods may be derived from the more primitive type as represented by *Archicladosoma* by assuming a reduction of the femorite. Some relationship seems to exist also with genera like *Cladethosoma,* in particular with *C. gladiator* Jeekel, 1982, and *Heterocladosoma,* especially *H. transversetaeniatum* (L. Koch, 1867), in which the femoral process is also simply rodlike. But in these genera the tibiotarsus is deeply split into two branches and the femoral process is coalesced in its basal part with the base of the solenomerite.

Key to the Species of Isocladosoma

1. Tibiotarsus of gonopods rodlike, without branches, distally truncate ..... *I. maculatum* n.sp.

—— Tibiotarsus of gonopods more complex, widening distally and bearing about halfway along its length a medial spine 2

2. Spinelike process of tibiotarsus short, not nearly reaching apex. Apex itself recurved, uncate. Median pale colour interrupted in waist area of somites, and before middle of collum ..... *I. guttatum* n.sp.

—— Spinelike process of tibiotarsus almost reaching apex. Apex itself curved a little, but not uncate. Median pale colour of somites and collum constricted in waist area of somites and on collum but uninterrupted ..... *I. pallidulum* n.sp.

Isocladosoma guttatum n.sp.

Material. Sta. 88, Glenaladale Nat. Park, 28 km WNW Bairnsdale, 15.xi.1980 (dry rainforest along creek, along nature track, under logs and stones and in litter), ♂ holotype, 1 ♂ paratype, 1 juv. ♂ paratype (18 somites), 4 ♀ paratypes.

Description. *Colour*: Head dark, almost blackish brown, darkest in vertigial region. Lower clypeal and labral areas, a narrow ring around antennal sockets, postantennal groove, lateral part of head plate and lateral sclerites brown. Antennae dark brown, 6th antennomere blackish; distal annuli of antennomeres narrow pale brown, tip of antennae whitish. Collum blackish brown, a small triangular spot at middle of anterior border and a broad triangle, pointing cephalad and reaching medially about halfway towards anterior border, and about as wide caudally as two-thirds of total width of collum, brownish yellow. Somites blackish brown dorsally, including paranota. Metatergites with a large median brownish yellow spot, about as wide as three-quarters of total width of metatergites, anteriorly not reaching waist. In posterior somites (about 17th to 19th), posterior border of metatergites narrowly infuscate. Prosomites except waist area also brownish yellow. Sides below paranota, venter, sternites and legs pale brown, dorsal side of 3rd to 5th podomeres and 6th podomere entirely infuscate; tip of tarsi pale, proximal podomeres faintly annulate with paler colour. Anal somite blackish brown; epiproct yellowish, yellowish colour extending medially in a pointed triangle on the ring. Paraprocts blackish brown, margins yellowish brown. Hypoproct pale brown.

Width: ♂ 2.7 mm; ♀ 2.9–3.0 mm; juv. ♂ (18s.): 1.6 mm.

Head and antennae: Labrum faintly but widely emarginate. Clypeus moderately convex, rather strongly

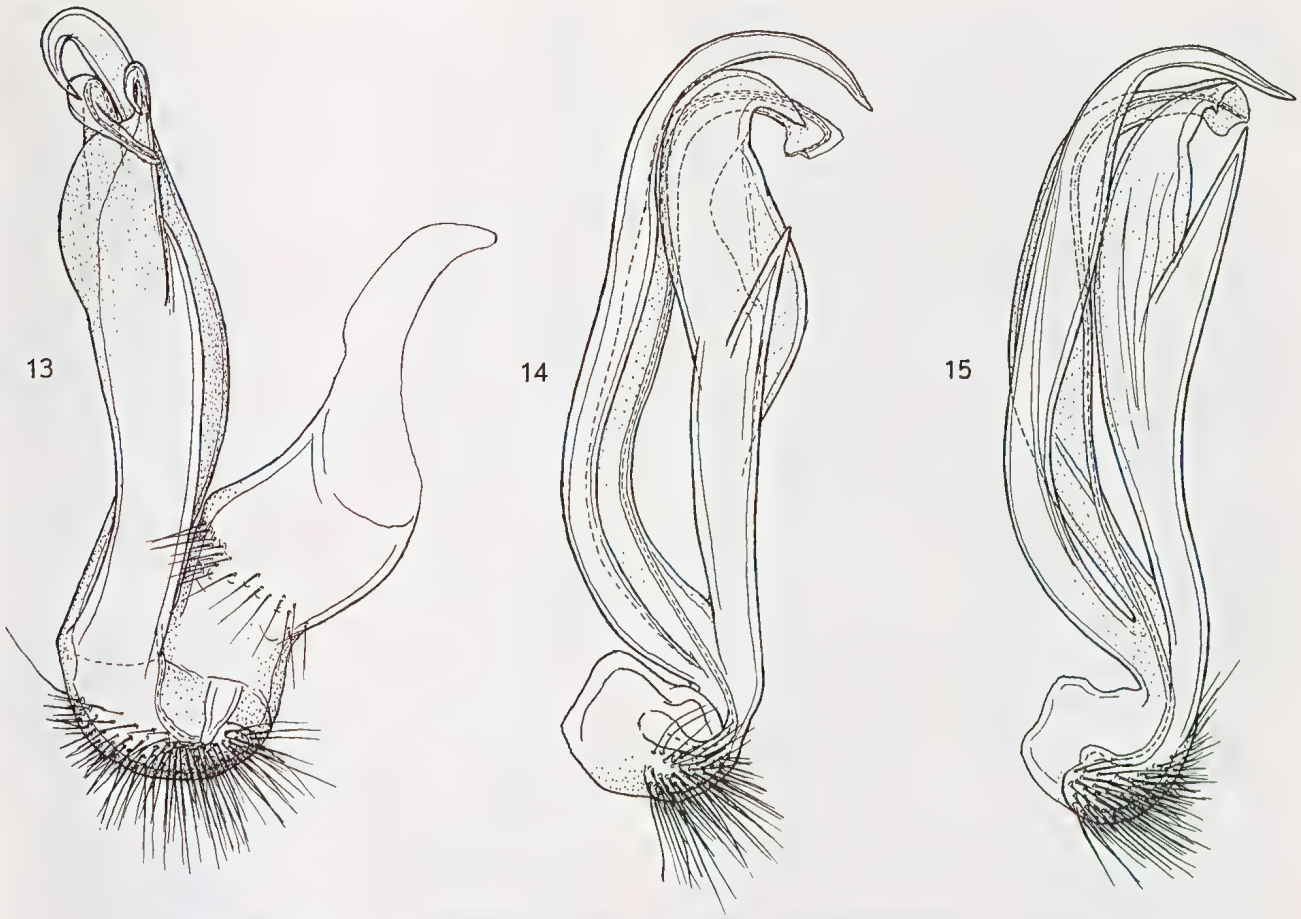
impressed towards labrum; lateral margin weakly convex, with a distinct notch near labrum. Headplate rather coarsely rugulose-punctate in lower part of clypeus, sparsely punctate in frontal region, otherwise smooth or somewhat wrinkled, shiny. Pubescence moderate in lower clypeal area, sparse in upper part of clypeus, frons, lateral parts and lateral sclerites; vertex hairless. Setae of moderate length to a little longish. Antennal sockets separated by 1.35 times diameter of a socket or by 0.7 times length of 2nd antennomere. Postantennal bean-shaped area narrow, rather distinctly demarcated and scarcely inflated. Postantennal groove moderately deep and rather wide; wall in front moderately prominent. Vertex longitudinally widely and evenly convex, transversely weakly concave in middle, laterally rather convex with a weakly raised but distinct swelling at latero-posterior edge. Vertigial sulcus moderately impressed, with some fine transverse wrinkles, reaching upper level of antennal sockets. Antennae of moderate length, somewhat stout, distinctly clavate. Antennomeres subcylindrical, each widening distad, becoming more obconical from 4th onwards, especially 5th; 6th antennomere faintly inflated. Relative length of antennomeres 2 to 6: 0.95, 1.00, 0.95, 0.85, 0.80. Pubescence moderate in proximal antennomeres, becoming rather dense in distal ones.

Collum: A little wider than head, subtrapezoidal in dorsal outline. Anterior border straight or faintly concave in middle, widely rounded more laterally, and straight or faintly concave again towards sides. Posterior border faintly concave in middle, widely rounded towards sides. Lateral border rather widely, asymmetrically rounded, strongest rounding anteriorly. Surface of collum shiny, smooth or very slightly rugulose, with fine median line; hairless. Surface transversely faintly convex, or almost flat in the middle, rather strongly convex laterally, sides perpendicular, longitudinally widely and evenly convex. Marginal rim laterally rather narrow, weakly raised, premarginal furrow disappearing at level of edge of vertex.

Somites: Constriction rather weak to moderate. Waist rather narrow, distinctly demarcated from prosomite, dorsally rather coarsely 'beaded', and from about level of paranota downward finely striate. Prosomite somewhat dulled by fine cellular structure, finely striolate. Metatergites smooth, or weakly and irregularly wrinkled, shiny, hairless. Transverse furrow present from 5th to 17th somite, faintly indicated on 18th. Furrow well impressed, with faint longitudinal striation, disappearing laterally at a distance from dorsal demarcation of paranota equal to about width of a poreless paranotum. Sides smooth or with some irregular wrinkles; those up to 4th somite minutely granular. Pleural keels represented by curved crenulate ridges in 2nd to 4th somite, dorsally demarcated by a furrow. In 5th somite only a weak longitudinal swelling, not demarcated. In 6th and 7th somites a strong longitudinal swelling, not demarcated, but especially prominent above the posterior legs. Pleural keels absent from 8th somite onwards.

Paranota: Second somite scarcely wider than collum; 3rd a little narrower than 2nd and about as wide as 4th. Paranota of 2nd somite with anterior border rather widely rounded, slightly thrust forward. Lateral edge subangular, narrowly rounded, with a weak, rounded lateroventral tooth. Lateral border straight from above, weakly rounded in caudal half, faintly diverging caudad. Caudal edge angular, quite narrowly rounded, slightly produced caudad, but hardly projecting behind margin of somite. Paranota ridgelike, situated on a rather low level, weakly prominent, lateral margin scarcely visible from above. In lateral aspect straight in anterior half, faintly curving upward a little in posterior half: margin of moderate and subequal width, faintly sloping cephalad. Premarginal furrow curving abruptly upward anteriorly towards waist, caudally rather abruptly, paralleling caudal margin of somite rather briefly. Paranota of 3rd somite from above laterally widely and almost evenly rounded, but almost straight near caudal edge. Posterior edge about rectangular, subacuminate, produced a little caudad and projecting scarcely beyond margin of somite. Posterior margin short, weakly emarginate. Paranota weakly prominent, of moderate dorsoventral width. Ventral demarcation weak.Upper furrow straight caudally, curving widely upward in anterior half towards waist. Paranota of 4th somite similar to those of 3rd, but laterally more evenly and a little more strongly rounded. Posterior edge more widely angular, narrowly rounded, slightly produced but not projecting. Dorsoventral width a little larger than in 3rd somite. Upper furrow in lateral aspect with a wider curve towards waist. Paranota of 5th and subsequent somites rather weakly prominent. Lateral border in dorsal aspect widely and almost evenly rounded, in poriferous somites a little more strongly convex at pore area. Posterior edge widely angular, acuminate, slightly produced but not projecting behind margin of somite. In 19th somite posterior edge almost absolete. Posterior margin quite short, weakly emarginate. Paranota in lateral aspect with upper furrow widely and weakly convex in poriferous somites, straight or a little concave in poreless ones; furrow running cephalad close to waist, caudad to near caudal margin of somite, but not paralleling caudal margin of somite. Dorsoventral width of paranota moderate, in poriferous somites one-and-a-half times larger than in poreless ones. Ventral demarcation by a depression distinct either in caudal half (poriferous somites) or in caudal third (poreless somites), slightly convex, converging in a rather acute angle with dorsal demarcation and meeting it in a pointed edge. Pores situated almost in between dorsal and ventral demarcations, or slightly closer to ventral demarcation, in a small ovoid excavation.

Sternites and legs: Sternites of middle somites longer than wide (ratio 1.3 : 1.0). Cross-impressions well developed, with longitudinal and transverse impressions almost equally wide, transverse becoming furrowlike only between successive coxal sockets. No sternal cones. Pubescence moderate to rather dense; setae of moderate



Figs 13, 14 & 15. *Isocladosoma guttatum* n.gen., n.sp., holotype ♂. **13:** right gonopod, medial aspect; **14:** telopodite of left gonopod, anterior aspect. **15:** *Isocladosoma pallidulum* n.sp., holotype ♂, telopodite of left gonopod, anterior aspect.

length to longish. Sternite of 4th somite relatively wide, rather deeply transversely concave, with a faint median furrow; coxal sockets slightly raised. Pubescence moderately dense. Sternite of 5th somite with a longish, parabolically rounded process between anterior coxae; process at base slightly wider than intercoxal space, its length about equal to its largest width. Process in profile directed downward and cephalad, projecting well in front of anterior margin of sternite. Anterior side in profile straight at base, rather strongly convex halfway and straight again in distal half. Anterior side of apex with a transverse brush of short setae. Posterior side in profile widely concave, basis a little convex. Pubescence moderate to rather sparse, setae longish. Transverse furrow well impressed. Posterior half of sternite a convex transverse wall without median impression, moderately pubescent with longish setae. Posterior coxae somewhat pressed aside, but coxal sockets scarcely raised. Sternite of 6th somite flattened, with coxae well separated. Anterior half faintly convex, posterior half flat and not raised above ventral level of metasomal ring. No longitudinal impression; transverse impression weak. Coxal sockets scarcely raised. Pubescence rather sparse, mostly present along anterior border of sternite; setae longish. Sternite of 7th somite in front of gonopod aperture with a weakly raised, somewhat callous wall. Coxae of ambulatory legs pressed aside a little. Sternite of 8th somite anteriorly flattened, raised only a little above ventral level of metasomal ring. Anterior coxae distinctly more widely separated than posterior ones. Coxal sockets raised a little. Longitudinal impression absent. Transverse impression faint, a little more distinct between the successive coxal sockets. Posterior half of sternite with a wide longitudinal impression, well raised near coxal sockets. Pubescence rather sparse. Legs of middle part of body of moderate length, somewhat incrassate. Prefemora dorsally rather strongly convex; femora ventrally faintly arched. Relative length of podomeres 2 to 6: 0.80, 1.00, 0.60, 0.65, 0.75. Ventral pubescence on all podomeres rather dense to moderate, setae of moderate length to longish. Dorsal pubescence apparent only in tarsi and, though much less, in tibiae. Scopulae dense in anterior legs up to about those of 8th somite, thinning out in legs of subsequent somites to become absent from legs of 15th to 18th somites. Legs of first pair strongly incrassate, and with elongate ventral femoral tubercle. Legs of 2nd pair with coxae medially slightly produced in a thick, low rounded cone.

Anal somite: Upper profile faintly convex, faintly impressed in front of base of epiproct. Epiproct of moderate length, and moderately thick, rather broad. Sides of epiproct straight, except at base where a little concave, weakly converging towards apex. Just beyond halfway a slight stepwise narrowing and from there the sides converge convexly towards the apex, which is rather broad and straight truncate. Setae not on tubercles. Paraprocts with rims of moderate width and height; setae not on tubercles. Hypoproct rather broadly triangular to subparabolical. Sides almost straight, apex widely rounded. Setae not on tubercles.

Gonopods (Figs 13, 14): Femoral process apically a little recurved. Solenomerite slender, scarcely widening halfway along its length. Tibiotarsus with rather broad stem, widening halfway along its length; its distal half bearing a broad, rounded lamella on caudal side. Apex uncate and a little recurved. Halfway along its length the tibiotarsus bears on its mediocephalic side a relatively short spine pointing distad.

Female: Clypeus rather strongly impressed towards labrum. Vertex transversely evenly convex; collum transversely almost evenly convex, faintly flattened in middle. Antennal sockets separated by 1.5 times diameter of a socket or by 0.85 times length of 2nd antennomere. Relative length of antennomeres 2 to 6: 1.00, 0.90, 0.80, 0.85, 0.75. Pleural keels a little more strongly developed than in male, but caudally rounded, absent from 5th somite onwards. Sternites of middle somites a s long as wide. Cross-impressions moderately developed, rather wide, sharp and furrowlike only between successive coxal sockets. Pubescence moderate, setae in part rather long. Legs much more slender than in male; femora straight; ventral pubescence moderately dense. Relative length of podomeres 2 to 6: 0.75, 1.00, 0.65, 0.55, 0.75. Coxae of 2nd legs medially and caudally somewhat callously inflated, opposite coxae medially contiguous. At mediocaudal side a low small swelling; from laterocaudal side arises a strong pointed spine, pointing laterad and a little caudad. Epigynal structure consisting of two wide emarginations embracing coxae, medially separated by a low pointed triangle; lateral side of emarginations a little raised.

Isocladosoma pallidulum n.sp.

Material. Sta. 92, Gunyah Gunyah, 32 km SSW Morwell, 17.xi.1980 (timber track along Grand Ridge Road, temperate rainforest with tree ferns, under logs and litter and in rotting trees), ♂ holotype, 1 ♂ paratype, 1 fragm. of ♀ paratype, 1 juv. ♀ (19 somites) paratype.

Description. *Colour*: This species has essentially the same colour pattern as the type species, but the lighter parts have extended at the expense of the dark-coloured areas. Moreover the light colour is yellowish white, and the dark colour sepia brown. Head with vertex sepia, finely areolated with minute whitish spots. Remaining parts of head diluted sepia to yellowish white. Antennae pale sepia, antennomeres distally annulate with yellowish white; 6th antennomere infuscate; tip of antennae whitish. Collum with two lateral sepia spots, medially separated by an anterior smaller yellowish white triangle and a posterior larger triangle merging just in front of the middle. Lateral margins narrowly yellowish white. Somites with a large yellowish white median band, broadest at caudal margin of each metatergite, and having a width there equal to about three-quarters of total width of metasomite, narrowest at waist. Remaining lateral part of tergites, including paranota, sepia-coloured; posterior edges of poriferous paranota a shade paler. Sides diluted sepia; venter and sternites beige. Basal podomeres beige, femora except for distal part vaguely infuscate. Three distal podomeres sepia, with large distal yellowish white annuli. Anal somite with rather wide yellowish white median band, widest at base of epiproct. Epiproct entirely yellowish white. Lateral sides of anal somite sepia, ventral half beige. Paraprocts sepia, margins whitish. Hypoproct beige.

Width: ♂: 2.4–2.5 mm; ♀: 2.9 mm; juv. ♀ (19 somites): 2.1 mm.

Head and antennae: Labrum moderately deeply and rather widely emarginate. Antennal sockets separated by 1.35 times diameter of a socket or by 0.65 times length of 2nd antennomere. Vertigial furrow faintly impressed in anterior part of vertex, not reaching upper level of antennal sockets. Relative length of antennomeres 2 to 6: 1.00, 0.95, 0.85, 0.85, 0.75.

Collum: Anterior border faintly convex towards sides. Sides almost evenly rounded. Surface of collum transversely a little incurved at lateral margin.

Somites: Pleural keels of 5th somite almost obsolete.

Paranota: 2nd somite a little narrower than collum; 3rd somite scarcely narrower than 2nd and as wide as 4th. Paranota of 2nd somite with anterior border weakly convex, scarcely thrust forward. Lateroanterior edge angular. Paranota of 5th and subsequent somites with posterior edge minute, acutely angular. Posterior margin quite short, more distinctly emarginate than in preceding species.

Sternites and legs: Sternites of middle somites 1.4 times longer than wide. Pubescence as in preceding species but a little less dense. Relative length of podomeres 2 to 6: 0.70, 1.00, 0.55, 0.65, 0.90. Scopulae less dense than in preceding species, absent from legs of 11th somite onwards. Ventral pubescence as in preceding species, but a little less dense.

Anal somite: Epiproct more or less parabolically rounded; sides convex near apex and with a slight stepwise narrowing there; apex faintly emarginate. Hypoproct almost evenly semicircularly rounded.

Gonopods (Fig. 15): Tibiotarsus with a large spinelike process reaching distad to near its apex. Apex of tibiotarsus curving a little mesad, widening a little and ending in three tiny lobes. Solenomerite widening a little halfway.

Female: (only the caudal half of a specimen available). Sternites 1.05 times longer than wide.

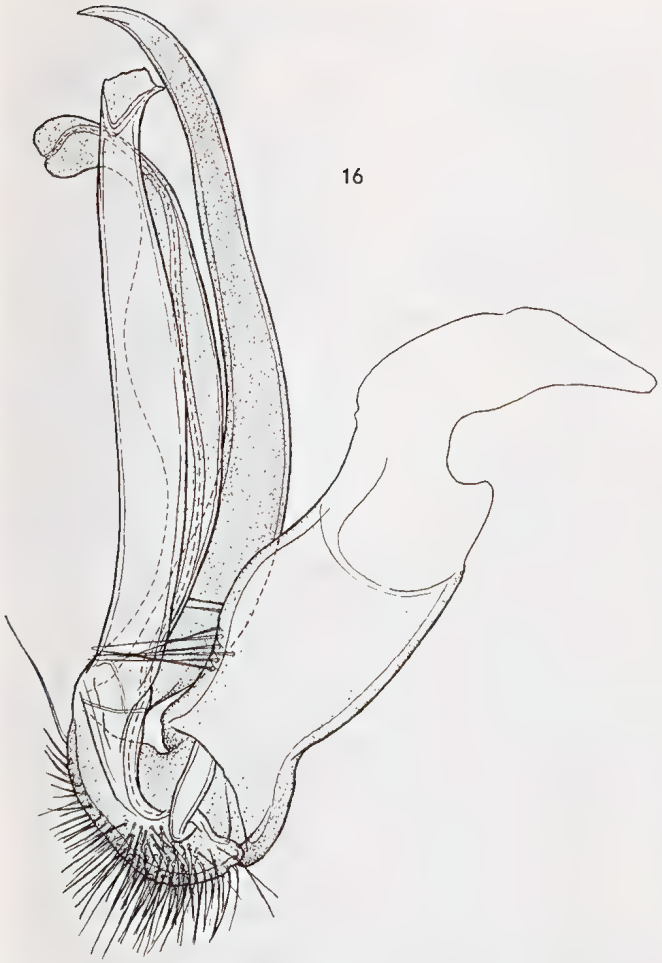


Fig. 16. *Isocladosoma maculatum* n.sp., holotype ♂, right gonopod, medial aspect.

Relative length of podomeres 2 to 6: 0.80, 1.00, 0.55, 0.55, 0.75.

Remarks. In the points not mentioned the description of *I. guttatum* applies. Although this species approaches *I. guttatum* in the structure of the gonopods, it is quite distinct in its colour pattern and in some morphological details like the development of the scopulae of the legs of the male.

Isocladosoma maculatum n.sp.

Material. Australia, without locality (a 6042), ♂ holotype, 1 ♂ paratype, 3 ♀ paratypes (American Museum of Natural History, New York).

Description. *Colour:*: The material has suffered from preservation, but the colour pattern as far as recognisable seems exactly the same as in *I. guttatum*.

Width: ♂ 2.4 mm; ♀ 2.7–3.0 mm.

Head and antennae: Labrum rather weakly and widely emarginate. Clypeus moderately impressed towards labrum. Lower clypeus rather weakly and sparsely punctate; pubescence also more sparse. Antennal sockets separated by 1.3 times diameter of a socket or by 0.8 times length of 2nd antennomere. Lateral swellings of vertex scarcely defined. Vertigial sulcus weak in lower part of vertex, not reaching upper level of antennal sockets. Relative length of antennomeres 2 to 6: 0.95, 1.00, 1.00, 0.90, 0.90.

Collum: Anterior border straight in middle, and straight towards sides.

Sternites and legs: Sternites of middle somites 1.4 times longer than wide. Relative length of podomeres 2 to 6: 0.80, 1.00, 0.60, 0.60, 0.80.

Gonopods (Fig. 16): Tibiotarsus slender, scarcely widening from base onwards, faintly tapering towards apex, which is irregularly truncate. No lateral spine. Solenomerite widening a little towards middle of length. Femoral process apically not recurved.

Female: Clypeus rather weakly impressed towards labrum. Antennal sockets separated by 1.2 times diameter of a socket or by 0.85 times length of 2nd antennomere. Relative length of antennomeres 2 to 6: 1.00, 0.90, 0.90, 0.85, 0.85. Sternites of middle somites scarcely longer than wide. Relative length of podomeres 2 to 6: 0.80, 1.00, 0.60, 0.55, 0.70. Coxa of 2nd legs without a distinct lateral spine, only with a little subconical lateral projection.

Remarks. In the points not mentioned the description of *I. guttatum* applies.

This species is quite similar to *I. guttatum* in colour and morphology, and can be properly distinguished only by the characters of the gonopods. The absence of the spine on the coxa of the 2nd pair of legs of the female may serve to distinguish the females.

Hoplatessara Verhoeff

Hoplatessara Verhoeff, 1928: 89, 92.—Jeekel, 1968: 25.
Hoplatessaropus Verhoeff, 1941: 9 (as subgenus of *Hoplatessara*).

Remarks. In the current concept, initiated by Jeekel (1968), this genus has six described species, which as far as geographical data are available occur in an area ranging from the Blue Mountains in New South Wales down to the surroundings of Melbourne.

Hoplatessara belongs to the group of Australiosomatini in which the telopodite of the gonopods is deeply split into four branches, the tibiotarsus consisting of two lanceolate prongs connected only at the very base. In this regard the genus agrees with *Cladethosoma*, but it is distinct in having the apex of the solenomerite trilobate, or exceptionally bilobate, with the spermal channel making a loop in the middle lobe before terminating in the most proximal lobe. The tibiotarsal prongs are solid, more or less circular in cross section, and in a number of species have a peculiar undulate structure towards their apex. The femoral process is lamellate, transversely flattened, and more or less spatulate apically, lacking the uncate process of *Cladethosoma*.

In the field the species may be recognized by a colour pattern showing a transverse annulation of black and dark reddish brown to yellowish brown. Morphologically they are rather similar, differing from each other mainly in the structure of the gonopods: the relative length of the four branches and the outline of the femoral process.

Various authors of species have used different names for the branches into which the telopodite of the gonopods is divided. To facilitate a comparison of the descriptions and drawings the terms used are listed hereunder.

	femoral process	*tibiotarsus*
anulata (Attems, 1931)	'Tarsus'	'Seitenäste der Tibia'
clavigera Verhoeff, 1928	tibiotarsus	lateral rami of femur
froggatti (Brölemann, 1913)	tarsal branch	tibial branch
luxuriosa (Silvestri, 1895), in Jeekel, 1956	femoral process	tibiotarsus
musgravei Verhoeff, 1928	tibiotarsus	lateral rami of the femur
pugiona Verhoeff, 1941	'Tibiotarsus'	'Parsolänomerite'

Key to the Species of *Hoplatessara*

1. Solenomerite apically bilobate or trilobate, with a rather long spinelike preapical process, more or less paralleling direction of apex. Femoral process scarcely reaching distad of solenomerite 2

——— Solenomerite apically trilobate, without preapical accessory branch. Femoral process generally overreaching solenomerite, sometimes quite considerably 3

2. Larger species: width of male 4.5 mm. Apex of solenomerite trilobate. Preapical spine of solenomerite curves a little proximad and crosses apex of solenomerite on its anterior side ..... *H. anulata* (Attems)

——— Smaller species: width of male 3.4–3.5 mm. Apex of solenomerite bilobate. Preapical spine of the solenomerite (i.e. enlarged distal lobe of apex) parallels distal part of solenomerite; both point mesad. ..... *H. luxuriosa* (Silvestri)

3. Femoral process greatly expanding in distal direction, overreaching solenomerite by about one-third of total length of acropodite. Tibiotarsal branches quite unequal in length; shorter branch about two-thirds of length of longer one ... *H. clavigera* Verhoeff

——— Femoral process generally overreaching solenomerite, but by much les than one-third of total length of acropodite. Tibiotarsal branches less different in length 4

4. Femoral process in anterior or posterior aspect of equal width from base to apex; distal part not widening conspicuously. Process overreaches the solenomerite distinctly ..... *H. pugiona* Verhoeff

——— Femoral process spatulate; rather narrow over most of its length and widening distally rather abruptly in a rhomboid, subquadrate or rounded apical lamina. Process reaches only a little distad of solenomerite 5

5. Solenomerite not conspicuously widening in its distal half ..... *H. froggatti* (Brölemann)

——— Solenomerite has an abrupt laminate expansion on its lateral side just distad of half its length 6

6. Apical lamina of femoral process sharply set off from its stem by a distinct constriction, margin of lamina irregularly serrulate. Proximad of the constriction femoral process has on its medial side a lobe covered with fine conical scales .... *H. nigrocingulata* n.sp.

——— Stem of femoral process widens gradually towards apical lamina; margin of lamina not serrulate ..... *H. musgravei* Verhoeff

Hoplatessara pugiona Verhoeff

Hoplatessara (Hoplatessarus) pugiona Verhoeff, 1941: 14, fig. 8.

Previous record. Whittlesea ('Whettlerea').

Material. Belgrave, 3.ii.1924, leg. Ch. Barrett (a 6045), 1 ♂, 2 ♀, 1 fragm. of ♀. (American Museum of Natural History, New York).

Sta. 93, Ferntree Gully Nat. Park, 18 km NNE Dandenong, 18.xi.1980 (along nature track in temperate rainforest with tree ferns, under logs and litter and in rotting trees), 1 ♀.

Description. *Colour*: Head dark brown or blackish; lower part of the clypeus and antennal sockets paler brown to yellowish. Antennae brown, darkest in distal parts of antennomeres; distal margins of antennomeres scarcely annulated with yellowish, the membranes pale; antennal tip whitish. Collum dark brown to blackish; anterior margin with a narrow yellow band fading away towards the sides; posterior margin with a similar, somewhat broader yellow band, broadest in middle, narrowing laterally. Somites brown to blackish; posterior half of metatergites yellow, sharply demarcated. Posterior half of paranota yellowish; lower and posterior parts of sides, venter, sternites and three proximal podomeres paler brown to yellowish; three distal podomeres infuscate. Anal somite blackish brown, epiproct yellow. Paraprocts brown, margins yellowish. Hypoproct yellow.

Width: ♂ 3.9 mm; ♀ 4.0–4.1 mm.

Head and antennae: Labrum moderately widely and moderately deeply emarginate. Clypeus rather convex, rather strongly impressed towards labrum. Lateral margin of clypeus widely convex, with distinct notch near labrum. Headplate punctate and rugulose in clypeal and lower frontal areas, smooth or slightly rugulose and shiny in upper frontal and vertigial parts. Pubescence rather sparse in clypeal and frontal regions, sparse on lateral sclerites; setae of moderate length to shortish. Vertex hairless. Antennal sockets separated by 1.3 times diameter of a socket or by 0.7 times length of 2nd antennomere. Postantennal groove rather deep and moderately wide, wall in front moderately prominent. Bean-shaped area at posterior side of sockets obsolete. Vertex transversely flat or even a little concave in middle, rather convex laterally but without lateral swelling. Vertigial sulcus moderately impressed, running downward to just above upper level of antennal sockets. Antennae of moderate length, stoutish, somewhat clavate. 2nd and 3rd antennomeres subcylindrical, each widening distad; 4th, 5th and 6th more obconical in shape. Relative length of antennomeres 2 to 6: 1.00, 0.95, 0.90, 0.85, 0.80. Pubescence moderate in proximal antennomeres to rather dense in distal ones.

Collum: A little wider than head, subtrapexoidal in dorsal outline. Anterior border straight or even faintly concave in middle, widely and weakly rounded more laterally, and straight or faintly concave towards sides. Posterior border weakly and widely concave in middle, widely rounded more laterally and straight towards sides. Lateral border rather widely and evenly rounded. Surface of collum smooth or with some irregular wrinkles, shiny, hairless. Surface transversely faintly convex or almost flat in middle, rather strongly convex laterally, sides almost perpendicular. Marginal rim laterally narrow, weakly raised; premarginal furrow distinct up to level of lateral edges of vertex, fading away towards middle of anterior border.

Somites: Constriction rather weak. Waist narrow, sharply demarcated from prosomites, dorsally distinctly striate to subcarinate, faintly striate below level of paranota. Prosomites dull, with fine cellular structure. Metatergites shiny, smooth or faintly rugulose, hairless. Transverse furrow present from 5th to 18th somites, rather strongly impressed, with faint sculpture, disappearing laterally at a distance from upper demarcation of paranota about equal to half dorsoventral diameter of a poriferous paranotum. Sides smooth or irregularly wrinkled, up to 4th somite minutely granular. Pleural keels represented up to 4th somite by a granulate ridge, dorsally demarcated by a furrow, in 3rd somite caudally slightly angular, in 4th without posterior edge. In 5th to 7th somites only scarcely-defined longitudinal swellings.

Paranota: Second somite a little wider than collum; 3rd scarcely wider than 2nd and as wide as 4th. Paranota of 2nd somite with anterior border weakly convex, about transverse. Latero-anterior edge widely angular, with a blunt latero-ventral tooth. Lateral margin almost straight, anteriorly weakly convex, posteriorly a little more strongly rounded. Lateral margin faintly diverging caudad. Posterior edge subangular, narrowly rounded, faintly produced and projecting. Posterior margin quite short, weakly convex. Paranota on a low level, lateral margin just visible from above. In lateral aspect margin narrow, more or less straight and of even width. Premarginal furrow curving abruptly upward anteriorly, and rather abruptly caudally, briefly paralleling caudal margin of tergite. Paranota of 3rd and 4th somites with lateral border in dorsal aspect widely and almost evenly convex, more widely rounded in 4th. Caudal edges subangular, narrowly rounded in a wide angle, weakly produced caudally and scarcely projecting caudad of posterior margin of somite. Posterior border short, weakly rounded. In lateral aspect paranota of the 3rd and 4th somites much wider dorso-ventrally than those of 2nd somite. Dorsal demarcation straight, curving upwards anteriorly towards waist and more abruptly so near the posterior margin; premarginal furrow briefly paralleling posterior margin of tergite. Ventral demarcation by a depression distinct in more than half length of paranota, curving upwards in an acute angle towards dorsal demarcation. Paranota of 5th and subsequent somites weakly prominent. Lateral border from above widely rounded; anteriorly, and in poriferous somites also posteriorly, a little more convex. Posterior edge subangular, narrowly rounded, slightly produced caudad; projecting slightly behind margin of somite from about 15th to 18th somite. Caudal angle a little wider than 90°. Posterior margin short, a little concave. In

lateral aspect dorsal demarcation faintly convex in poriferous somites and straight or faintly concave in poreless ones. Premarginal furrow running towards waist, curving upward anteriorly, but not reaching waist; furrow curving upwards abruptly at caudal border and briefly paralleling caudal margin of tergite. Paranota dorso-ventrally moderately wide; poreless paranota about two-thirds of width of poriferous ones. Ventral demarcation more or less straight, converging rather strongly towards upper margin, and meeting it in an acute, more or less narrowly rounded angle; angle in poreless somites narrower than in poriferous ones. Pores in a small ovoid excavation, situated a little closer to ventral demarcation than to dorsal.

Sternites and legs: Sternites of middle somites longer than wide (ratio 1.3:1.0). Cross-impressions well developed, transverse impression a little narrower than longitudinal one. No sternal cones. Pubescence moderate to rather dense; setae of moderate length. Sternite of 4th somite rather wide, with a wide but not deep longitudinal impression. Sternite of 5th somite with broad shovel-like process, which is a little wider than distance between anterior coxae, and about one-and-a-half times as broad as long. Process widely parabolically rounded to subpentagonal with a quite wide distal angle. Process directed cephalad and a little ventrad, projecting well in front of anterior border of sternite. Anterior surface widely convex; posterior surface in profile convex at base, widely concave distally. Apex anteriorly with a dense transverse brush of short setae; posterior surface sparsely set with longish hairs. Behind process a rather deep transverse furrow. Posterior half of sternite consisting of a rounded wall between coxal sockets, medially hardly impressed. Pubescence rather sparse; setae longish. Sternite of 6th somite entirely flattened, not raised above level of ventral side of metasomal ring. Transverse impression weak and wide, no longitudinal impression. Coxal sockets rather widely separated, not particularly raised. Pubescence rather sparse, moderate at anterior margin and near coxal sockets; setae of moderate length to rather long. Sternite of 7th somite with a weak transverse ridge on each side in front of gonopod aperture. Coxae pressed aside a little. (8th somite missing.) Legs moderately long, stoutish. Femora faintly arched; prefemora rather strongly convex dorsally. Ventral pubescence rather dense on all podomeres; setae of moderate length. Dorsal pubescence apparent only in tibiae and tarsi. Scopulae present on anterior legs, absent from 14th somite onwards (somites 8 to 13 missing). Relative length of podomeres 2 to 6: 0.70, 1.00, 0.65, 0.65, 0.80. First leg strongly incrassate and with the usual ventral femoral tubercle. Coxa of 2nd leg mediodistally shortly truncate. Coxae of 6th somite medially faintly produced, rounded.

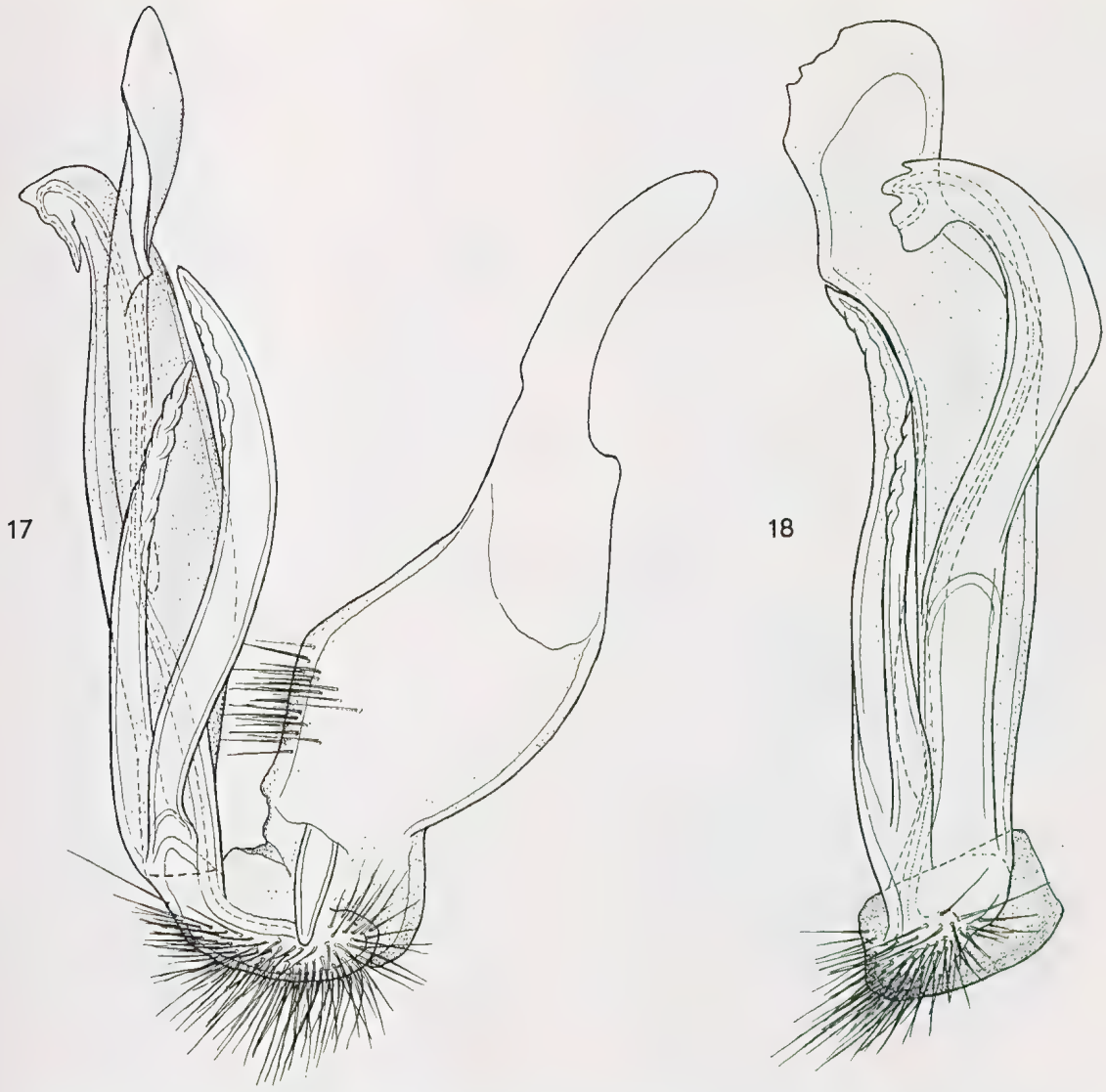
Anal somite: Upper profile weakly convex, with a rather faint and wide depression in front of base of epiproct. Epiproct longish, rather thick dorso-ventrally, broad. Sides rather weakly converging, straight or widely concave, not entirely parallel near apex, and without stepwise narrowing. Setae not on tubercles. Apex broadly truncate, scarcely emarginate, edges narrowly rounded. Ventral side a little concave. Paraprocts with moderately wide and rather low marginal rims. Setae on weak swellings. Hypoproct broadly parabolically or almost semicircularly rounded. Setae not on tubercles.

Gonopods (Figs 17, 18): Tibiotarsal branches differing a little in length: medio-anterior branch longer than latero-posterior one. Undulate structure distinct in both branches. Junction of solenomerite and femoral process situated at about two-fifths of length of femoral process. Solenomerite showing only a slight expansion halfway; its apex three-pronged, distal prong short. Femoral process projecting distinctly distad of solenomerite, its transverse width remaining equal over most of its length, apex irregularly serrate, not expanded.

Female: Clypeus only slightly less impressed than in male. Vertex transversely almost evenly convex. Antennal sockets separated by 1.5 times diameter of a socket or by 0.8 times length of 2nd antennomere. Relative length of antennomeres 2 to 6: 1.00, 0.95, 0.90, 0.75, 0.70. Collum transversely widely and almost evenly convex, only slightly less convex in middle. Pleural keels in 2nd somite caudally rounded and a little produced, in 3rd somite caudally rather prominent, narrowly rounded but not produced, in 4th somite caudally widely rounded. In 5th somite only a faint longitudinal swelling; none in subsequent somites. Sternites a little longer than wide (ratio 1.1:1.0). Cross-impressions with transverse impression rather deep and narrow; longitudinal impression wide. Legs not incrassate, femora straight, prefemora much more weakly convex on dorsal side. Ventral pubescence present on all podomeres but distinctly more sparse than in male. Relative length of podomeres 2 to 6: 0.80, 1.00, 0.55, 0.55, 0.75. Epigynal structure absent: anterior side of venter of 3rd somite faintly emarginate, without median process. Coxae of 2nd pair of legs with two rounded cones on posterior side: a mediocaudal low and rounded conical process pointing caudad, and a latero-caudal and more distally situated similar process, which is a little longer, is more acuminate-subconial, and points caudo-laterad.

Remarks. The above description was made to extend the rather brief account by Verhoeff. It is obvious that Verhoeff misinterpreted the structure of the femoral process (called tibiotarsus in his description), and described its apex as 'stabartig verdünnt'. This observation was based on an examination of the gonopod in a medial aspect only, and in such a position the laminate apex suggests a narrow process. In an anterior or posterior aspect the true shape of the apex becomes apparent.

H. pugiona seems to come nearest to *H. clavigera* Verhoeff, 1928, from an unknown locality, probably in New South Wales, with which it agrees in the general shape of the femoral process. In *H. clavigera*, however, the process is much longer in relation to the length of the scolenomerite and the tibiotarsal branches, and overreaches the apex of the solenomerite by one-third of the total length of the acropodite.



Figs 17 & 18. *Hoplatessara pugiona* Verhoeff, ♂. **17:** right gonopod, medial aspect; **18:** telopodite of left gonopod, caudal aspect.

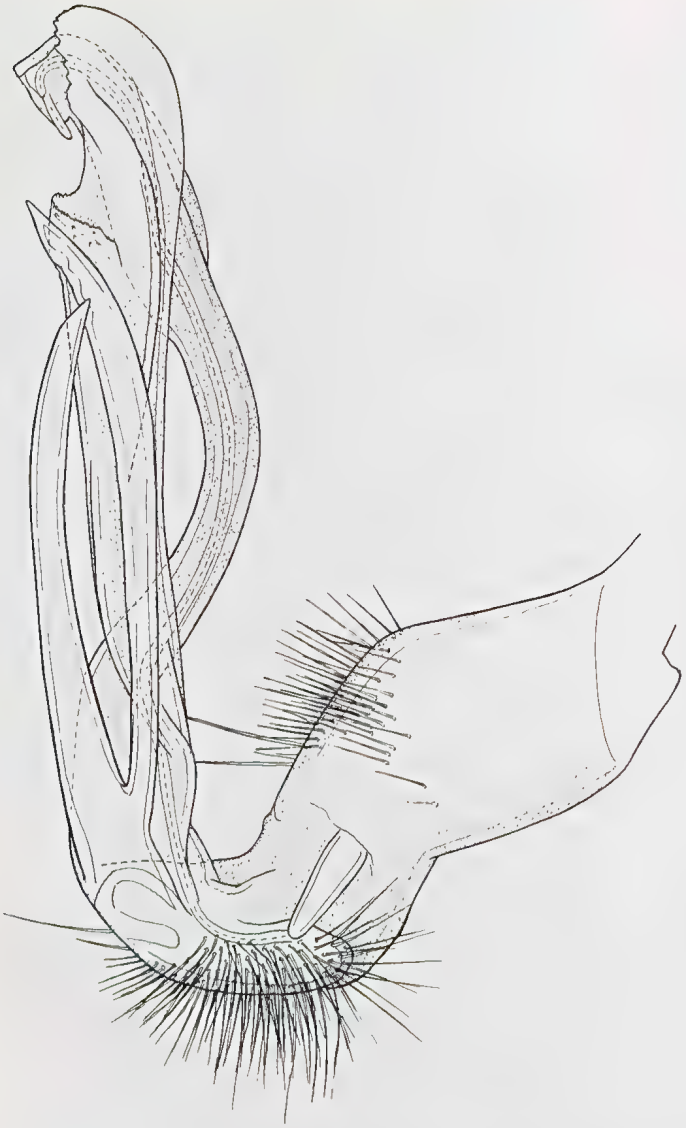
Hoplatessara nigrocingulata n.sp.

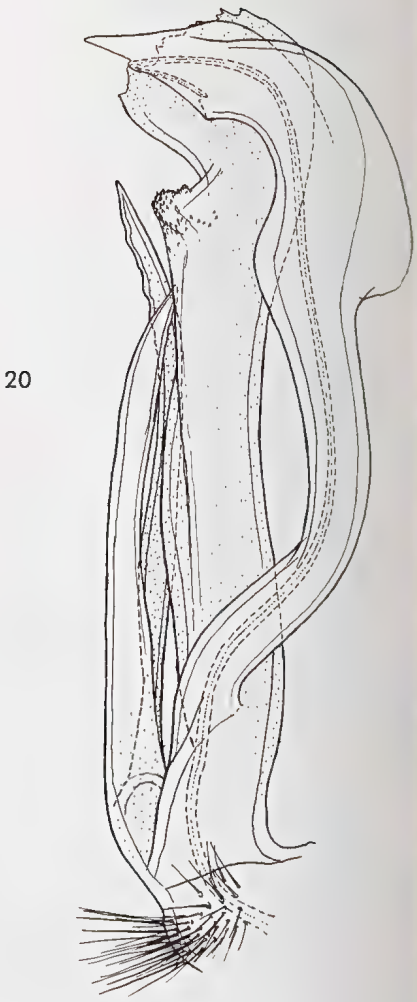
Material. Australia, without locality (A 5763, 4588d), ♂ holotype (American Museum of Natural History, New York). Australia, without locality (A 5763, 4598), ♂ paratype (American Museum of Natural History, New York).

Description. *Colour*: Vertex, frontal and upper clypeal region brownish black; lower part of clypeus, a narrow ring around antennal sockets and lateral parts of head brown to orange brown. Antennae with basal antennomere orange brown, remaining antennomeres brown, infuscate towards their distal end; intersegmental membranes pale, antennal tip whitish. Collum blackish brown, with rather narrow brown anterior and lateral margins, posterior border up to two-fifths of length of collum, brown, marginal zone narrowing laterad. Somites with anterior part of prosomites and metasomites including paranota and sides brown to orange brown; waist and parts of pro- and metasomites adjacent to waist blackish brown; on metatergites blackish colour extends over one-fifth of their length. Lower part of sides, venter, sternites and three proximal podomeres orange brown to yellowish; three distal podomeres brown, tip of tarsi pale. Anal somite and paraprocts blackish brown; entire epiproct including a medio-dorsal part of anal ring, margins of paraprocts and entire hypoproct orange brown to yellowish.

Width: ♂ 4.1–4.2 mm.

Head and antennae: Labrum weakly and widely emarginate. Lateral margin of clypeus faintly convex, without distinct notch near labrum. Pubescence moderately dense in clypeal and lower frontal area, upper frons and vertex hairless; setae shortish. Antennal sockets separated by 1.4 times diameter of a socket or by 0.6 times length of 2nd antennomere. Bean-shaped





Figs 19 & 20. *Hoplatessara nigrocingulata* n.sp., holotype ♂. **19:** right gonopod, medial aspect; **20:** telopodite of left gonopod, caudal aspect.

area behind antennal sockets vaguely indicated, not swollen. Vertigial sulcus rather well impressed, scarcely reaching upper level of antennal sockets. Relative length of antennomeres 2 to 6: 1.00, 1.00, 0.90, 0.90, 0.75. Pubescence rather dense in proximal antennomeres to dense in distal ones.

Collum: Anterior border straight in middle, widely rounded more laterally and straight again along sides. Posterior border widely and relatively deeply emarginate in middle, straight or faintly convex laterally. Surface longitudinally weakly and almost evenly convex; transversely weakly convex in middle, more strongly convex laterally, sides almost perpendicular.

Somites: Waist rather narrow, dorsally distinctly striate, striation becoming finer and weaker on sides down to level of stigmata. Sides smooth or very finely rugulose, dispersedly granular near posterior border, up to 5th somite granular all over. Pleural keels represented in 2nd and 3rd somites by faint, scarcely demarcated ridges, caudally not raised or produced. In 4th to 7th somite only weakly defined longitudinal swelling, which in 7th somite is distinct only above the posterior pair of legs.

Paranota: Anterior border in 2nd somite straight. Latero-anterior edge narrowly rounded, with a faint lateral tooth. Lateral border in dorsal aspect straight or faintly convex, a little more convex in posterior half. Posterior edge narrowly rounded, faintly produced caudad and projecting a little behind margin of somite. Posterior margin obsolete. Paranota of 2nd somite not visible from above, except posterior edge. In lateral aspect margin rather narrow, straight, curving a little upwards in caudal half. Paranota of 3rd and 4th somites with upper demarcation widely concave, curving upwards anteriorly, and turning abruptly upward caudally near posterior margin. Paranota of 5th and

subsequent somites with posterior edges projecting slightly caudad of margin in 14th and 16th to 18th somites only. Ventral demarcation of paranota about straight or sometimes even a little concave, converging not strongly, and meeting upper demarcation in a quite acute, almost pointed angle.

Sternites and legs: Ratio of length and width 1.3:1.0. Setae of moderate length to longish. Process of 5th sternite parabolically rounded, without apical angle. Ridge in front of gonopod aperture in 7th somite moderately prominent. Sternite of 8th somite with anterior coxal sockets a little more separated than posterior ones. Anterior half of sternite flat, not raised above ventral level of metasomal ring; coxal sockets not raised. Transverse impression faint. Posterior half more normally raised and with a distinct median impression, which is rather wide. Pubescence moderate to rather dense; setae of moderate length with a few long ones. Legs rather long and stoutish. Dorsal pubescence conspicuous on all podomeres. Scopulae well developed in anterior legs, but thinning out rapidly in postgonopodial somites and absent from 13th to 14th somite onwards. Relative length of podomeres 2 to 6: 0.65, 1.00, 0.60, 0.60, 0.70.

Anal somite: Upper profile straight or faintly convex, without distinct basal impression. Epiproct of moderate length and width, rather broadly truncate. Sides straight or faintly convex, converging moderately, not parallel near apex and with faintly indicated stepwise narrowing near apex.

Gonopods (Figs 19, 20): Tibiotarsal branches differing a little in length as in preceding species; undulate structure developed only in the longer of the two branches. Junction of solenomerite and femoral process situated at about one-fifth of length of femoral process. Solenomerite abruptly expanded distally. Apex three-pronged, but distal prong clearly longer than other two lobes, which are recurved cephalad. Femoral process spatulate, widening distally, with a medial lobe covered with minute scales, and a distal rounded and irregularly serrulate apex; apex scarcely projecting distad of solenomerite.

Female: Unknown.

Remarks. In the points not mentioned the description of *H. pugiona* applies. According to the shape of the femoral process *H. nigrocingulata* belongs in a group of species which has *H. anulata* (Attems, 1931) and *H. musgravei* Verhoeff, 1928, from the Blue Mountains, *H. froggatti* (Brölemann, 1913), from Mt. Sassafras, all in New South Wales, and *H. luxuriosa* (Silvestri, 1895) from an unknown locality. In all these species, the apex of the femoral process is spatulate, consisting of a long, narrowish stem, which widens apically more or less abruptly to form a rounded or ovoid blade. In most species the apical lamina is marked proximally by a constriction, which appears to be absent only in *H. musgravei*. The latter species may be distinguished from *H. nigrocingulata* also by the fact that the femoral process reaches distinctly farther distad than the solenomerite. In *H. froggatti* the solenomerite apparently lacks the large laminate expansion which is characteristic for *H. nigrocingulata* and *H. musgravei*. In general aspect the gonopods of *H. anulata* are quite similar to those of *H. nigrocingulata*, and the only clear distinctive character is found in the supplementary spine emanating from the solenomerite just proximad of its apex. Finally, *H. luxuriosa* distinguishes itself from all other species of *Hoplatessara* by the fact that the distal prong of the apex of the solenomerite is widely separated from the other two prongs, appearing as a separate preterminal process of the solenomerite.

Some Aspects of the Distribution of the Victorian Paradoxosomatidae

With the completion of the present study of the Paradoxosomatidae of Victoria the number of known species is elevated from five to fifteen plus one subspecies. The Victorian list now looks as follows:

Antichiropodini

Pogonosternum nigrovirgatum nigrovirgatum (Carl, 1902)
P. n. infuscum Jeekel, 1982
P. coniferum Jeekel, 1965
P. laetificum Jeekel, 1982
P. adrianae Jeekel, 1982
Dicranogonus pix Jeekel, 1982

Australiosomatini

Archicladosoma magnum n.sp.
Hoplatria clavigera Verhoeff, 1941
Australiosoma laminatum n.sp.
Somethus biramus n.sp.
Cladethosoma forceps (Verhoeff, 1941)
Isocladosoma guttatum n.sp.
I. pallidulum n.sp.
I. maculatum n.sp.
Hoplatessara pugiona Verhoeff, 1941
H. nigrocingulata n.sp.

As far as known, all the species are endemic, with one exception: the range of *S. biramus* extends into the extreme south of New South Wales.

The rate of endemicity of genera is lower, which is of course not surprising considering the fact that Victoria is a political concept rather than a physical-geographic unit. On the available (partly not yet published) information, only *Archicladosoma, Hoplatria* and *Isocladosoma* fall into this category: three genera out of nine.

Pogonosternum and *Dicranogonus* have as yet undescribed representatives in NW Tasmania and on the islands of the Furneaux group respectively (Jeekel, in preparation). The only other faunistic connection between Victoria and Tasmania concerns the genus *Somethus,* which has two species in N and NW Tasmania. This genus is, moreover, also represented in South Australia (Jeekel, in press) and appears to be the south-eastern Australian genus with the largest area of distribution.

Australiosoma, Cladethosoma and *Hoplatessara* are Victorian elements with north-eastern connections. Their range extends northward to the New England region (*Australiosoma*), southern Queensland (*Cladethosoma*) and the Blue Mountains (*Hoplatessara*). Since these three genera show their greatest diversity in New South Wales, it seems likely that the Victorian representatives are intruders from the north which reached Victoria through migration along the Great Dividing Range.

The genera *Pogonosternum, Dicranogonus, Archicladosoma, Hoplatria, Somethus* and *Isocladosoma* are probably to be regarded as endemics of a southern Australian area, which includes besides Victoria also Tasmania and South Australia. It seems likely that Victoria was a centre of dispersal, from which *Pogonosternum, Dicranogonus* and *Somethus* migrated towards the south and west. The distributional picture of *Pogonosternum* and *Somethus* suggests a route of dispersal from Victoria to north-west Tasmania. The distribution of *Dicranogonus* seems to indicate that migration from Victoria southward towards Tasmania along a north-eastern route was blocked south of the Furneaux group.

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A new Australian scincid lizard, *Menetia concinna*, from the Alligator Rivers region, Northern Territory ..... ROSS A. SADLIER Page 45

Systematics of the pachynid group of lysianassoid Amphipoda (Crustacea) ..... J. K. LOWRY Page 51

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A New Australian Scincid Lizard, *Menetia concinna*, from the Alligator Rivers Region, Northern Territory

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ABSTRACT. Four species of the genus *Menetia* occur in the Alligator Rivers region of the Northern Territory. The new species *Menetia concinna* is described with an account of its distribution and that of its congeners in the region, *M. alanae* Rankin, *M. greyii* Gray and *M. maini* Storr.

SADLIER, ROSS, A., 1984. A new Australian scincid lizard, *Menetia concinna*, from the Alligator Rivers region, Northern Territory. Records of the Australian Museum 36(2): 45–49.

The genus *Menetia* was formerly regarded as monotypic with a nearly Australia-wide distribution. Recent studies by Storr (1976, 1978) described the new species *Menetia maini, M. surda* and *M. amaura* in Western Australia while Ingram (1977) described the new species *M. zynja* and *M. timlowi* from Queensland. Rankin (1979) revised the *Menetia* species occurring in the Northern Territory, describing the new species *Menetia alanae* and reviewing the status of *M. greyii* and *M. maini* in that area; he placed *M. zynja* in synonomy with *M. maini*.

In the course of reviewing *M. greyii*, Rankin (1979) tentatively identified as *M. greyii* a specimen from Cahills Crossing on the East Alligator River, while noting that it possibly represented a new species. Field work in the region of the Jabiluka uranium mining project area 19 km SW of Cahills Crossing has produced further specimens, confirming Rankin's suggestion of a new species from that area. In this paper I describe the new species, provide an account of the habitat and known distribution, furnish an updated key to the *Menetia* species of the Northern Territory and report range extensions for the three other species known from the Northern Territory.

Taxonomy

The terms used here for the headshields bordering the rostral margin of the eye differ from those used by previous workers.

Rankin (1979) used the term *presuboculars* for those scales located below a diagonal line drawn between the posterior loreal and the subocular supralabial (giving 1 presubocular in *M. greyii*, and 2 in *M. alanae*). This usage was also adopted by Ingram (1977) and Storr (1978).

The scale definitions employed here follow Peters (1964). The two large scales immediately preceding the eye and abutting the posterior loreal are the *upper* and *lower preoculars*. The scales posterior to the lower preocular, and interposed between the orbit and the supralabials, are *suboculars* (= the second presubocular described by Rankin for *M. alanae*) (see Fig. 2).

Key to the Species of *Menetia* Occurring in the Northern Territory

1. Second supraciliary contacting prefrontal, preventing contact between the first supraciliary and first supraocular 2

—— Second supraciliary not contacting prefrontal, allowing contact between first supraciliary and first supraocular ..... *M. maini*

2. Anterior subocular present 3

—— Anterior subocular absent ..... *M. greyii*

3. Midbody scale rows 22–24; pale midlateral stripe absent; poor demarcation between dorsal and upper lateral zone in adults ..... *M. alanae*

—— Midbody scale rows 20; pale midlateral stripe present at least anteriorly to level of forelimb; dorsal surface well demarcated from upper lateral zone . *M. concinna*

Fig. 1. Photograph of a live specimen of *Menetia concinna*.

Menetia concinna n.sp.

Figs 1, 2

Diagnosis. *M. concinna* can be distinguished from all other members of the genus by the following combination of characters: second supraciliary contacting the prefrontal, preventing contact between first supraciliary and first supraocular; anterior subocular present; ear opening present; midbody scale rows 20; bold dark upper lateral zone well defined from lighter dorsal surface and prominent pale midlateral stripe present anteriorly at least to level of forelimb.

Holotype. Australian Museum R88583, Jabiluka uranium mining project area, Northern Territory, 12°33′S 132°55′E; grid reference 729118 sheet 5472 (Edition 1) National Map Series "Cahill" (Division of National Mapping); collected by R.A. Sadlier, 8 August 1979.

Paratypes. All Australian Museum specimens are from the Jabiluka uranium mining project area, NT, collected by R.A. Sadlier August/September 1979.

AM R88584-88587 (same data as holotype); AM R88696, AM R88746, AM R88814, grid reference 691208 sheet 5473 (Edition 2) Series R621, "East Alligator", 12°28′S 132°52′E, 21-22 August 1979.

AM R88896, AM R88989, grid reference 768156 sheet 5472 (Edition 1) National Map Series, "Cahill", 12°31′S 132°57′E, 18 September 1979.

Northern Territory Museum (NTM) 2665, (not NTM 2885 as cited by Rankin [1979] with inaccurate locality of Cahills crossing, East Alligator River), 34.5 km SW Oenpelli, NT, collected by D. Metcalfe and P. Horner, 28 December 1976.

Description. Maximum SVL 31 mm; axilla to groin length 61.4–64.5% of SVL ($\bar{x}$ = 62.8, N = 8);

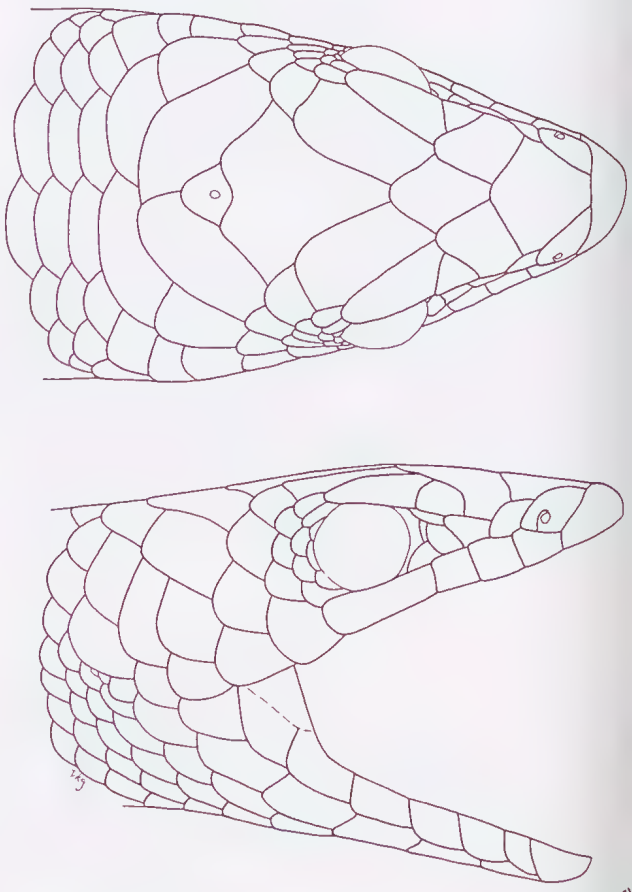

Fig. 2. The head of the holotype of *Menetia concinna* (AM R88583) in dorsal and lateral view.

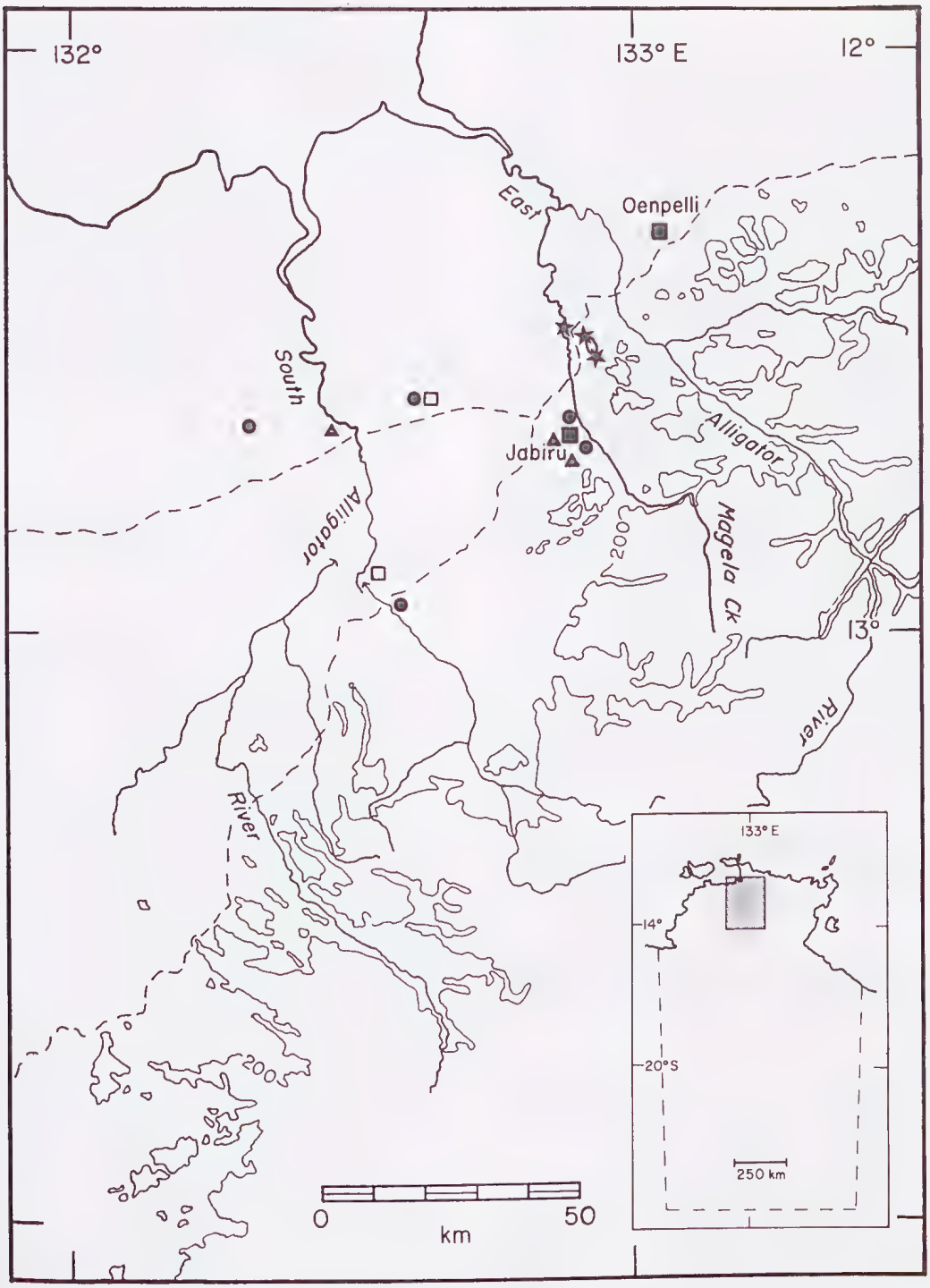

Fig. 3. Map showing the distribution of the four species of *Menetia* encountered in the Alligator Rivers region.
★ *M. concinna* □ *M. maini*
● *M. greyii* ▲ *M. alanae*
Inset: map of the Northern Territory with shaded sector showing the position and area occupied by main map.

hindlimb length 29.0–34.5% of SVL ($\bar{x}$ = 31.9, N = 8); forelimb to snout length 32.2–36.4% of SVL ($\bar{x}$ = 34.3, N = 8); tail length 132.7–181.8% of SVL ($\bar{x}$ = 155.6, N = 3).

Nasals moderately separated with the naris situated centrally; prefrontals large, narrowly separated (70%) or in point contact; frontoparietals fused, forming single shield; interparietal distinct; parietal eye prominent and situated anteriorly in interparietal; single pair of nuchals; supraciliaries 3, second contacting prefrontal; two loreals in horizontal series; upper preocular elongate and narrow, lower preocular almost as wide as high; single anterior subocular; upper labials 6, fourth below centre of eye; lower eyelid an immovable clear spectacle

covering eye; ear opening small and partially covered by large scale anteriorly.

Dorsal scales smooth, in 20 rows at midbody; paravertebral scales 58–61 ($\bar{x}$ = 59.7, SD = 0.9, N = 9) counted from first scale behind parietals to a point opposite posterior margin of preanal scales; lamellae beneath fourth toe 16–19 ($\bar{x}$ = 18, SD = 0.8, N = 9), each with a pale brown flat callus.

Colour and pattern in alcohol. Dorsally light brown-grey with fine dark spotting on each scale, most prominent medially and on head shields. Upper lateral stripe dark brown-black, commencing at base of rostral and passing through eye, recommencing broadly (equal in width to diameter of orbit) behind eye and continuing along body, weakening posterior to hindlimb to become a mottled area of lighter brown and cream flecks barely distinguishable from slightly lighter dorsal tail colour. White midlateral stripe from anterior upper labials passing through ear and over forelimb, sometimes continuing to midway down body, becoming more diffuse posteriorly and disappearing a short distance behind hindlimb. Line of fine dark flecks below midlateral stripe anteriorly between ear and forelimb, continuing as light brown and cream mottle over most of lower lateral region of body, excluding tail. Fore- and hindlimbs mottled. Venter white. Soles light brown, subdigital lamellae mid-brown without obvious dark calli. Juvenile specimens with light grey-brown dorsum, sharply demarcated from bold dark upper lateral zone, prominent pale midlateral stripe continuing to groin.

Distribution and habitat. All known specimens of *M. concinna* are from the western edge of the Arnhem Land escarpment on the East Alligator River drainage (Fig. 3).

Specimens from the Jabiluka project area were collected from a number of widely separated woodland sites, with a single observation from the top of a sandstone outlier.

The species was most commonly found beneath the numerous leaf piles in open riparian woodland (AM R88583-88587), being collected by removing the leaf litter and sifting through the thin layer of finer material remaining over the compact sand substrate.

The two locations at which specimens were pit-trapped were mixed woodland with a dense leaf litter cover and fine sand substrate; one site was in *Eucalyptus miniata* woodland on the eastern edge of the Jabiluka Billabong flood plain fringe (AM R88696, AM R88746, AM R88814), while the other site bordered a tributary of Swift Creek (AM R88896, AM R88989) close to the main escarpment. NTM 2665 was recorded as "active in leaf litter near escarpment".

Throughout the two months of field work on the Jabiluka project area, which involved extensive pit-trapping over a wide range of habitats, the only species of *Menetia* encountered was *M. concinna*. From the adjacent Jabiru project area 10–14 km south, both *M. greyii* and *M. alanae* were recorded. *Menetia greyii* was pit-trapped on two occasions in open woodland with speargrass on the lateritic soils that cover much of the project area, while *M. alanae* was recorded from two sites in the mixed eucalypt woodland of the sandy levee banks of Gulungul Creek, running from the Mt Brockman massif. On the Magela Creek drainage *M. alanae* and *M. concinna* occupy nearly identical riparian habitats at two adjacent sites, while *M. greyii* occupies the totally different open woodland habitat.

Etymology. The name *concinna* was proposed in manuscript by the late Peter Rankin. It is Latin for "pleasing on account of the harmony and proportions of its parts; elegant; neat".

Comments. Rankin's examination (1979) of *M. greyii* was comprehensive. I have examined specimens of *M. greyii* from the Northern Territory lodged in the Australian Museum and those specimens added to the NTM collection since Rankin's study. My results are consistent with that work.

The only point of possible disagreement is the juvenile specimen NTM 2828 from 32 km NE of Oenpelli which Rankin tentatively placed in *M alanae*. This specimen has 22 midbody scale rows, prefrontals narrowly separated, no evidence of an anterior subocular on either side and no trace of a pale midlateral line or a thin dark dorsolateral line (but the specimen is markedly discoloured by formalin). In life it was reported to have had a bright blue tail (Mr Brian Jukes, cited in Rankin, 1979). A colour transparency of a subadult *M. greyii* (Australian National Wildlife Collection ANWC 3499) taken by Mr John Wombey also shows a blue tinge to the tail. Hence this specimen is more likely to be *M. greyii* than *M. concinna* or *M. alanae*.

Collections made by the Division of Wildlife Research and Rangelands in surveying the Kakadu region have recorded *M. alanae* (ANWC 3459-3460, 3492, 3497-3498) from open forest and *M. greyii* (ANWC 3377, 3499) from woodland sites associated with the South and East Alligator drainage systems. Also among these collections are specimens of *M. maini* (ANWC 2675, 3494-3496) not previously recorded from the Alligator Rivers region, which were collected from rainforest sites on the very upper reaches of the South Alligator River and from a lowland woodland site.

The records of *M. alanae* from the Jabiru project area represent a significant easterly extension (220 km) to the range presented by Rankin (1979). Specimens from the Alligator Rivers region differ from those from the type locality, SE of Mt Carr, in that the prefrontals are in point contact or narrowly separated; topotypic specimens have the prefrontals broadly contacting.

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Dr H. Cogger, Dr A. Greer, Dr J. Paxton, Mr Glen Shea, Dr G. Storr and Dr R. Zwiefel reviewed drafts of this paper at different stages; I am grateful for their constructive criticisms. Phlyp Greer prepared all the illustrations.

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Systematics of the Pachynid Group of Lysianassoid Amphipoda (Crustacea)

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ABSTRACT. A monophyletic group of genera, the pachynid group, is established within the lysianassoid amphipods for genera with an extremely compressed carpus and enlarged propodus on gnathopod 1. Two subgroups within the pachynids are established for genera with smooth or with sculptured spine-teeth on maxilla 1. Four new genera—*Sheardella, Drummondia, Acheronia* and *Ekelofia*—and 10 new species—*Sheardella kapala, S. tangaroa, Drummondia corinellae, D. parviramus, Pachynus pugilator, P. denticulatum, Figorella tasmanica, Acheronia pegasus, Pachychelium schellenbergi* and *P. nichollsi*—are described. A further 4 genera and 8 species are rediagnosed or redescribed. *Pachychelium mediterraneum* is transferred to *Prachynella* and *Ekelofia* is established for *Pachychelium oculatum.*

LOWRY, J.K., 1984. Systematics of the pachynid group of lysianassoid Amphipoda (Crustacea). Records of the Australian Museum 36(2): 51–105.

CONTENTS

Introduction 52
The Pachynid Group 52
Key to the Genera and Species of the Pachynid Group 53
The Sculptured-toothed Subgroup 54
Sheardella n.gen. 54
Sheardella kapala n.sp. 54
Sheardella tangaroa n.sp. 61
Drummondia n.gen. 61
Drummondia corinellae n.sp. 64
Drummondia parviramus n.sp. 65
Prachynella J.L. Barnard 72
Prachynella lodo J.L. Barnard 72
Prachynella mediterranea (Ruffo) 72
The Smooth-toothed Subgroup 72
Pachynus Bulycheva 72
Pachynus pugilator n.sp. 78
Pachynus chelatum Bulycheva 78
Pachynus barnardi Hurley 78
Pachynus denticulatum n.sp. 84
Figorella J.L. Barnard 86
Figorella tasmanica n.sp. 86
Figorella tanidea J.L. Barnard 92
Acheronia n.gen. 92
Acheronia pegasus n.sp. 93
Ekelofia n.gen. 97
Ekelofia oculata (Schellenberg) 97

Pachychelium Stephensen 99
Pachychelium schellenbergi n.sp. 102
Pachychelium nichollsi n.sp. 103
Pachychelium antarcticum Schellenberg 104
Pachychelium davidis Stephensen 104
Acknowledgements 105
References 105

Pachychelium was originally described by Stephensen (1925) from the Davis Strait west of Greenland. Thirty years later Bulycheva (1955) described *Pachynus* from the Sea of Japan. J. L. Barnard (1962), in his study of the deep-sea amphipods of the South Atlantic Ocean, described *Figorella* from the East Scotia Basin near South Georgia. Soon after, J.L. Barnard (1964) described *Prachynella* from the continental shelf off southern California.

The relationship between these genera has never been fully appreciated and at no time have they been considered as a monophyletic group. Bulycheva (1955) and Gurjanova (1962) both recognized the relationship of *Pachynus* to *Pachychelium*. J.L. Barnard (1962) mentioned some character-states which differentiated *Figorella* and *Pachychelium* and considered the relationship of *Figorella* to *Koroga* Holmes and *Pseudokogora* Schellenberg. Although J.L. Barnard (1964) compared *Prachynella* with *Pachychelium* and *Pachynus* he did not mention his recently described genus *Figorella*. In J.L. Barnard's (1969a) keys to the lysianassoid genera, all of the above-mentioned genera except *Pachychelium* fall out in the same key even though Barnard did not necessarily intend to indicate phylogenetic relationships.

These genera do in fact form a monophyletic group within the lysianassoid amphipods. The groups is characterized by the body form, mouthpart morphology and, most importantly, the peculiar condition of gnathopod 1 in which the carpus is extremely compressed and the propodus is greatly enlarged.

In the collections of the Australian Museum and the Museum of Victoria I have identified 6 species from Australia and New Zealand with gnathopod 1 in this condition, but I could not confidently place any of them in existing genera based on current diagnoses. Consequently I borrowed material of all known species for study. In this paper all known genera in the pachynid group are re-diagnosed on the basis of their type-species. Four new genera and 9 new species are described, and a key to all genera and species is provided.

Material is deposited in the Allan Hancock Foundation, Los Angeles (AHF); the Australian Museum, Sydney (AM); the American Museum of Natural History, New York (AMNH); Museo Civico di Storio Naturale, Verona (MCSN); Museum of Victoria, Melbourne (NMV); National Museum of New Zealand, Wellington (NMNZ); Swedish Museum of Natural History, Stockholm (SMNH); Zoologisches Museum, East Berlin (ZMB); Zoologisk Museum, Copenhagen (ZMC).

The following abbreviations are used in the figures: A1, 2: antenna 1, 2; G1, 2: gnathopod 1, 2; l: left, r: right; MD: mandible; MX1, 2: maxilla 1, 2; MP: maxilliped; P3-7: peraeopod 3-7; T: telson; U1-3: uropod 1-3; UR: urosome.

The Pachynid Group

The pachynid group of genera is a monophyletic group characterized by gnathopod 1, which has a peculiarly compressed carpus and enlarged propodus. The proximal articles of the flagellum of antenna 1 are usually fused and bear rows of aesthetascs; calceoli are never present on either antenna. On the mandible, the molar is always absent, the incisor has a smooth cutting edge, and the left lacinia mobilis and the accessory spines may or may not be present or a serrate blade (lamina dentata) may be present. The mandibular palp is always 3-articulate. On maxilla 1 the inner plate is usually small and may or may not have terminal setae, the outer plate has from 11 to 4 spine-teeth. The palp may be present or absent; if present it bears either terminal articulating spines or setae. The maxillipeds may or may not have inner plates, the outer plates are always at least moderately enlarged and the palp is usually 4-articulate, occasionally 3-articulate. Gnathopod 1 may be subchelate, parachelate or chelate and the palm may be defined by a simple spine, a complex spine, a projecting tooth or not at all, but the carpus is always compressed and the propodus is always enlarged. Gnathopod 2 is a typical lysianassoid mitten which is usually minutely subchelate, but occasionally the dactyl and palm are enlarged. Coxa 4 usually has a well developed posteroventral lobe but occasionally this lobe is absent or poorly developed. Article 4 of peraeopods 5 and 6 is usually expanded posteriorly. Uropods 1 and 2 are biramous. Uropod 3 is usually biramous, occasionally uniramous, with the outer ramus always 2-articulate. The telson is small, entire, and slightly broader than long.

The group can be divided into two distinct subgroups: the sculptured-toothed pachynids, which are characterized by a long, thin, straight body with a shallow, horizontal, anthurid-like mouthpart bundle, sculptured spine-teeth on maxilla 1 and elongate, tapering plates

on maxilla 2; and the smooth-toothed pachynids, which are characterized by a stocky, comma-shaped body with a hypognathous, v-shaped mouthpart bundle, smooth spine-teeth on maxilla 1 and short, mainly subquadrate plates on maxilla 2.

As defined in this study the pachynid group is composed of 8 genera: *Sheardella* n.gen., *Drummondia* n.gen., *Prachynella* J.L. Barnard, *Pachynus* Bulycheva, *Figorella* J.L. Barnard, *Acheronia* n.gen., *Ekelofia* n.gen. and *Pachychelium* Stephensen.

Key to the Genera and Species of the Pachynid Group

1. Maxilla 1, outer plate with most spine-teeth sculptured; maxilla 2 long, thin, tapering distally 2

—— Maxilla 1, outer plate with spine-teeth smooth; maxilla 2 short, plates usually subquadrate, occasionally tapering 7

2. Maxilla 1, palp 2- or 1-articulate with several teminal setae; uropod 3 uniramous ..... *Sheardella* ... 3

—— Maxilla 1, palp absent or vestigial; uropod 3 biramous, inner ramus may be vestigial 4

3. Maxilla 1, palp 2-articulate ..... *S. kapala*

—— Maxilla 1, palp small, 1-articulate ..... *S. tangaroa*

4. Mandible, serrate blade present; maxilliped, palp 4-articulate ..... *Drummondia* ... 5

—— Mandible, serrate blade absent; maxilliped, palp 3-articulate ..... *Prachynella* ... 6

5. Peraeopods 3 to 7, setae encased in sheaths ..... *D. corinellae*

—— Peraeopods 3 to 7, setae not encased in sheaths ..... *D. parviramus*

6. Maxilla 1, outer plate with 10 spine-teeth in a 7/3 formula ..... *P. lodo*

—— Maxilla 1, outer plate with 8 spine-teeth in a 5/3 formula ..... *P. mediterranea*

7. Gnathopod 1 with simple or complex spine defining palm 8

—— Gnathopod 1 with produced tooth or nothing defining palm 14

8. Maxilla 1, palp present; maxilliped, inner plates present 9

—— Maxilla 1, palp absent; maxilliped, inner plates absent ..... *Ekelofia oculata*

9. Antenna 1, flagellum without fused proximal articles bearing aesthetascs maxilla 1, outer plate with 10 spine-teeth, palp with terminal setae; gnathopod 1, palm defined by simple spine ..... *Figorella* ... 10

—— Antenna 1, flagellum with fused proximal articles bearing aesthetascs; maxilla 1, outer plate with 7–8 spine-teeth, palp with terminal spines; gnathopod 1, palm defined by complex spine ..... *Pachynus* ... 11

10. Antenna 1, accessory flagellum 1-articulate; maxilla 1, outer plate spine-tooth formula 6/4; uropod 3, inner ramus shorter than article 1 of outer ramus ..... *F. tanidea*

—— Antenna 1, accessory flagellum 2-articulate; maxilla 1, outer plate spine-tooth formula 5/5; uropod 3, inner ramus subequal in length to article 1 of outer ramus ..... *F. tasmanica*

11. Gnathopod 1 subchelate to chelate; peraeopod 7, article 2 about as long as broad; uropods without denticles 12

—— Gnathopod 1 extremely chelate; peraeopod 7, article 2 longer than broad; uropods with denticles ..... *Pachynus denticulatum*

12. Gnathopod 1 chelate 13

——Gnathopod 1 subchelate ..... *P. pugilator*

13. Gnathopod 2, article 6 more than twice as long as broad; peraeopod 5, article 4 with posteoproximal corner broadly rounded ..... *P. chelatum*

——Gnathopod 2, article 6 less than twice as long as broad; peraeopod 5, article 4 with postero-proximal corner narrowly rounded ..... *P. barnardi*

14. Maxilla 1, palp absent; maxilliped, inner plates absent; coxa 4, postero-ventral lobe absent ..... *Pachychelium* ... 15

——Maxilla 1, palp present; maxilliped, inner plates present; coxa 4, postero-ventral lobe well developed ..... *Acheronia pegasus*

15. Maxilliped, palp 3-articulate 16

——Maxilliped, palp 4-articulate 17

16. Gnathopod 1, palm defined by well-developed tooth ..... *P. antarcticum*

——Gnathopod 1, palm without defining tooth ..... *P. davidis*

17. Gnathopod 1, articles 2 and 3 greatly enlarged; peraeopod 7, article 2 with broadly rounded posteroventral corner ..... *P. schellenbergi*

——Gnathopod 1, articles 2 and 3 not greatly enlarged; peraeopod 7, article 2 with sharply rounded posteroventral corner ..... *P. nichollsi*

The Sculptured-toothed Subgroup

Sheardella n.gen.

Diagnosis. Antenna 1, flagellum with fused proximal articles bearing rows of aesthetascs only in reproductive male stage. Mandibles with lacinia mobilis absent, well-developed accessory spines present. Maxilla 1, inner plate subquadrate with several terminal setae; outer plate with 11 spine-teeth (8 sculptured, 3 smooth in a 7/4 formula); palp small, 2- or 1-articulate, with 2 small terminal setae. Maxilla 2 with long, thin, tapering plates; outer plate longer, with medial and terminal setae; inner plate with several terminal setae. Maxilliped, inner plates small, with several apical setae; outer plates large, reaching end of 4-articulate palp. Gnathopod 1 subchelate; palm defined by 2 simple spines. Coxa 4 with well-developed posteroventral lobe. Peraeopods 5 and 6, article 4 expanded posteriorly, with weak posteroproximal shoulder. Peraeonite 5 without posterodorsal tooth. Uropod 3 uniramous.

Type-species. *Sheardella kapala* n.sp.

Etymology. The genus is named after Dr Keith Sheard in recognition of his contribution to the systematics of Australian Amphipoda.

Remarks. *Sheardella* is similar to other sculptured-toothed pachynid genera, *Drummondia* and *Prachynella*, in body shape, the shape of the mouthpart bundle, the absence of the lacinia mobilis and the long slender second maxilla. It differs from them in having a palp on maxilla 1, accessory spines on the mandible and simple teeth defining the palm of gnathopod 1, and in not having posterodorsal tooth on peraeonite 5 or inner ramus on uropod 3.

Sheardella contains 2 species, *S. kapala* and *S. tangaroa*, which live along the continental shelf and bays of south-eastern Australia.

Sheardella kapala n.sp.

Figs 1–3

Type-material. HOLOTYPE, female, 5.0 mm, AM P32390; 2 PARATYPES, AM P32391; east of Port Jackson, New South Wales, Australia, 33°52'S 151°23'E, epibenthic sled in shelly mud, 80 m, R.T. Springthorpe on FRV *Kapala*, 11 December 1980, Station K80-20-11.

Additional material examined. Two specimens, AM P22895, 2 km E of Long Bay, New South Wales, Australia, 33°58'S 151°17'E, 66 m, Australian Museum Shelf Benthic Survey, 30 July 1973, Station IV. One specimen, AM P24231, E of Malabar, New South Wales, Australia, 33°57'S 151°19'E, Shipek grab, sandy gravel, 92 m, Australian Museum Shelf Benthic Survey, 22 May 1972. Eight specimens, NMV J1702, Bass Strait, Australia, 40°13.8'S 148°39.6'E, epiben-thic sled, muddy sand, 60 m, Victorian Institute of Marine Sciences, Cruise 81-T-1 on RV *Tangaroa*, 14 November 1981, BSS Station 165.

Diagnosis. Maxilla 1, palp well-developed, 2-articulate. Gnathopod 1, palm transverse. Gnathopod 2, article 5 about 3 times as long as broad, palm transverse. Peraeopods 5 and 6, article 4 longer than broad, slightly expanded posteriorly.

Description. Holotype female, 5.0 mm. *Antenna 1*: peduncular article 1 about 1.5 times as long as articles 2 and 3 combined, peduncle about 3 times as long as

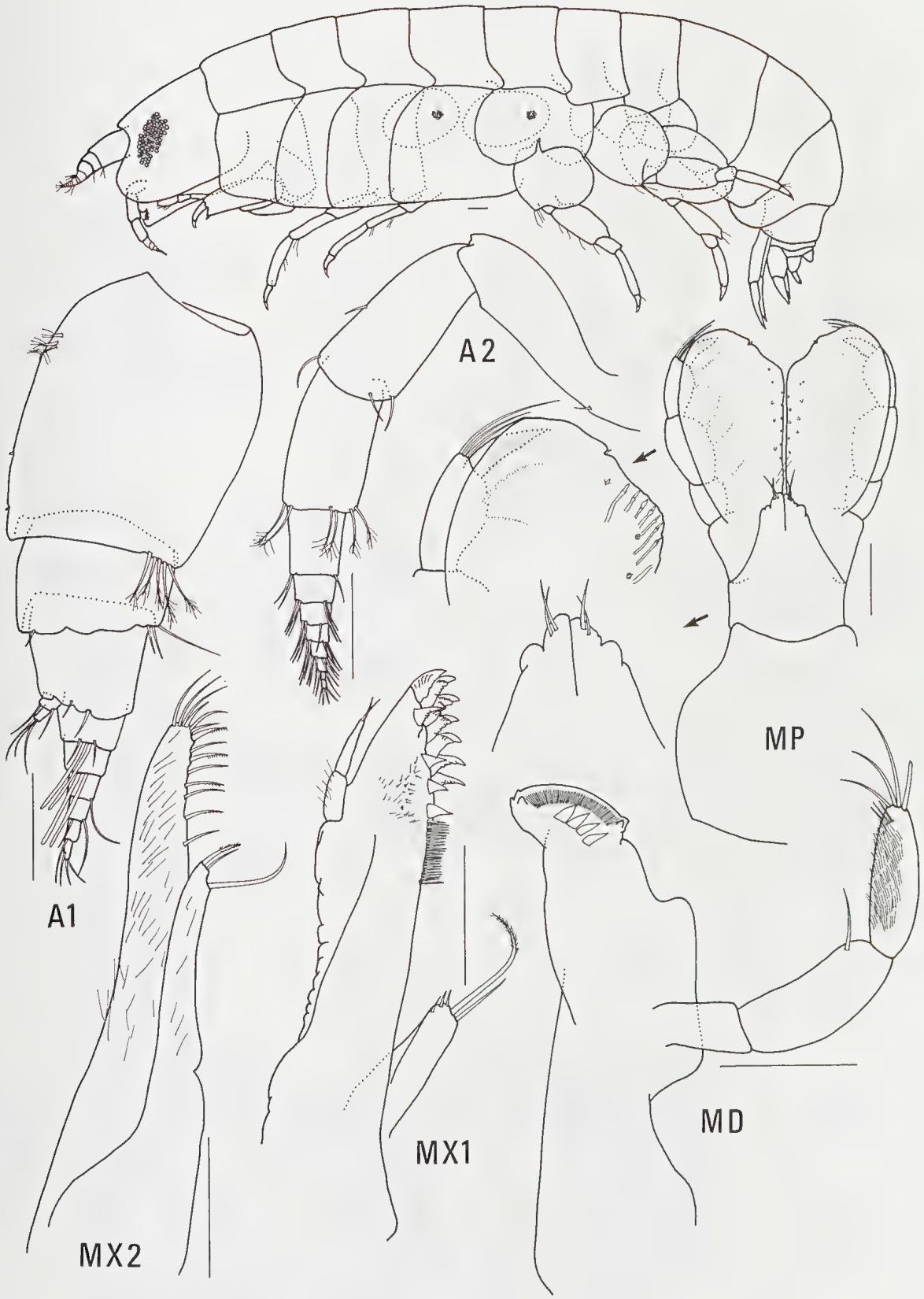

Fig. 1 *Sheardella kapala* n.gen. n.sp., holotype, female, 5.0 mm, E of Port Jackson, New South Wales, Australia. Scale represents 0.1 mm.

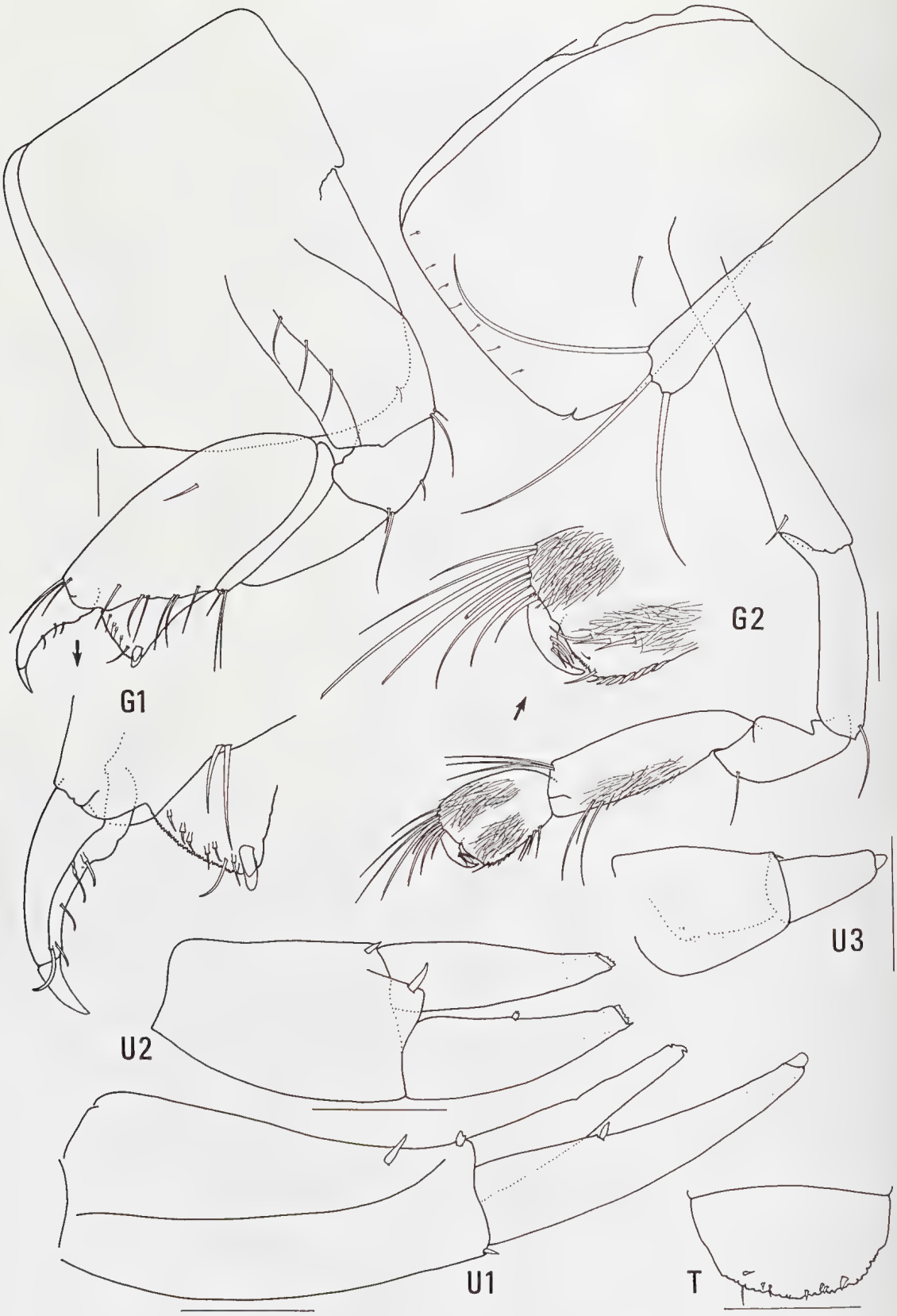

Fig. 2 *Sheardella kapala* n.gen. n.sp., holotype, female, 5.0 mm, E of Port Jackson, New South Wales, Australia. Scale represents 0.1 mm.

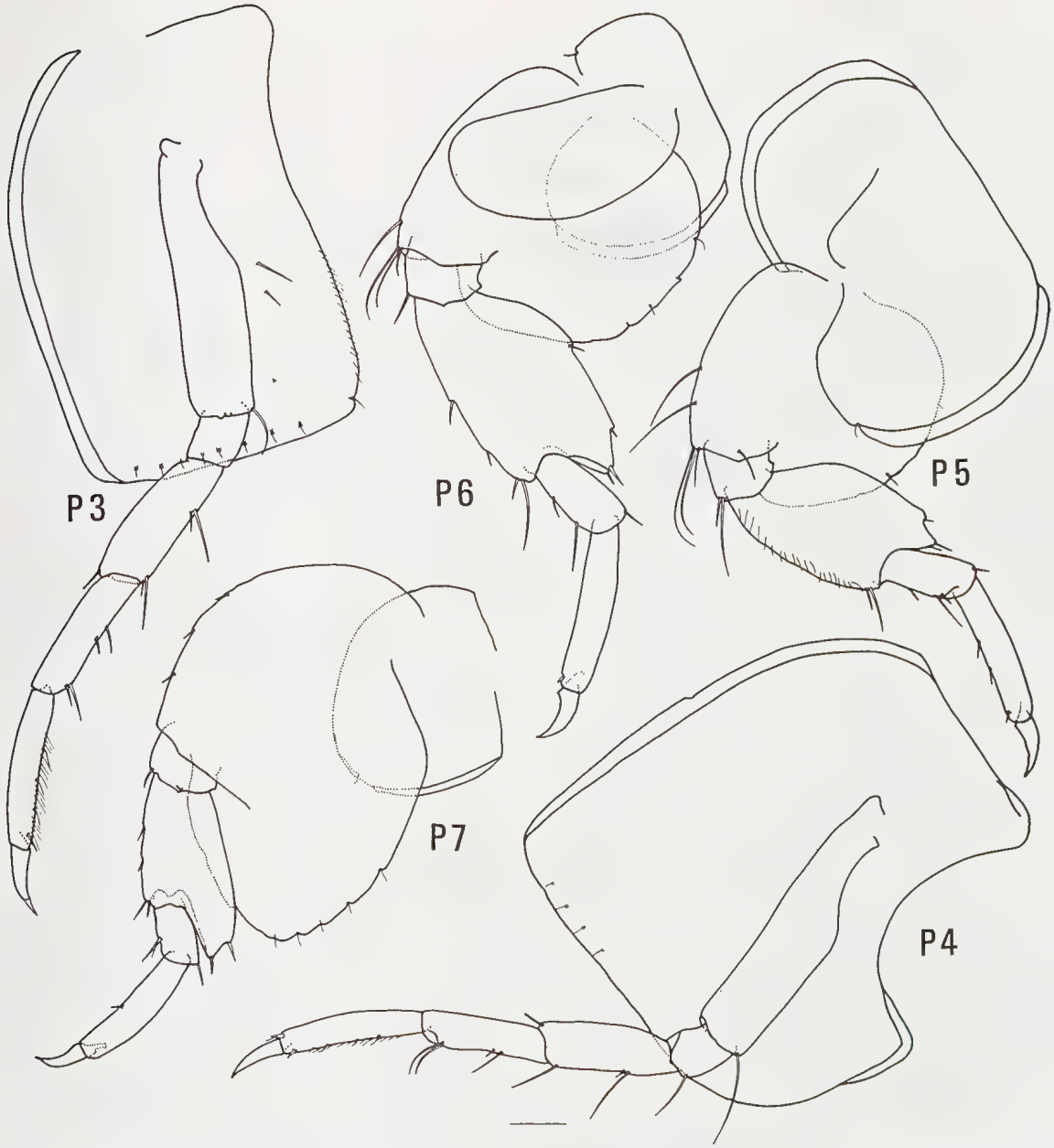

Fig. 3 *Sheardella kapala* n.gen. n.sp., holotype, female, 5.0 mm, E of Port Jackson, New South Wales, Australia. Scale represents 0.1 mm.

flagellum; flagellum 6-articulate; accessory flagellum 2-articulate. *Antenna 2* slightly longer than antenna 1; flagellum 8-articulate.

Mandible: incisor broad with a smooth cutting edge; lacinia mobilis absent; 4 broad accessory spines present; palp attached midway along dorsal margin, article 2 broad, slightly longer than article 3, with 1 mediodistal seta, article 3 with rows of minute hairs and 4 strong apical setae. *Maxilla 1*: inner plate small, narrow, subquadrate, with 1 large apical plumose seta, 1 small apical seta and 3 small subapical setae; outer plate with 11 spine-teeth in a 7/4 formula, and a strong row of short, stout setae; palp small, 2-articulate with 2 small terminal setae. *Maxilla 2* long, thin, tapering distally; inner plate with 3 terminal setae; outer plate with 8 serrate setae along medial margin and 6 terminal setae. *Maxilliped*: inner plates reduced, each with 2 apical setae; outer plates subovate, large, reaching slightly beyond end of 4-articulate palp.

Gnathopod 1 subchelate, large; coxa subquadrate; article 6 large, nearly 2.5 times as long as broad, palm transverse, defined by 2 broad blunt spines, tip of dactyl slightly overreaching palm. *Gnathopod 2* subchelate; article 5 about 3 times as long as broad; article 6 with transverse palm and a row of about 7 serrate spines along posterodistal margin.

Peraeopod 3: coxa longer than broad, subquadrate; dactyl short. *Peraeopod 4*: coxa as long as broad,

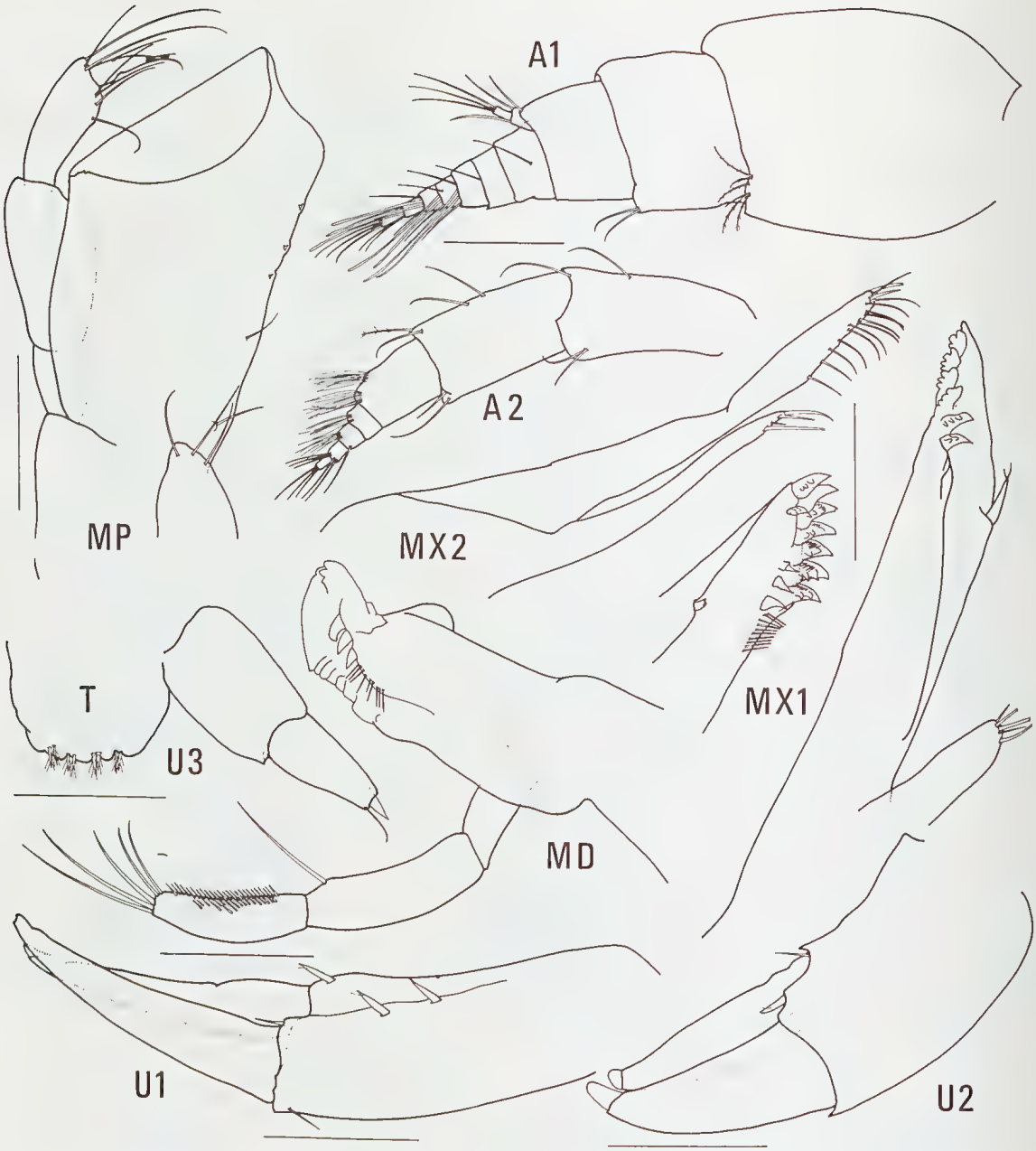

Fig. 4 *Sheardella tangaroa* n.gen. n.sp., holotype, female, 4.0 mm, E of Crib Point, Western Port, Victoria, Australia. Scale represents 0.1 mm.

strongly produced posteroventrally, otherwise similar to peraeopod 3. *Peraeopod 5*: article 2 with posterior margin rounded; article 4 large, slightly expanded posteriorly. *Peraeopod 6*: article 2 with posterior margin rounded; article 4 large, slightly expanded posteriorly. *Peraeopod 7*: article 2 larger than article 2 of peraeopods 5 and 6, subovate posteriorly with a slightly crenulate margin; article 4 narrow with 2 small posterodistal setae.

Uropod 1: peduncle slightly longer than rami; outer ramus longer than inner ramus, with a small mid-dorsal spine. *Uropod 2* shorter than uropod 1; rami subequal in length, outer ramus with small mid-dorsal spine. *Uropod 3* shorter than uropod 2, uniramous; peduncle longer than ramus. *Telson* entire, broader than long, slightly rounded distally with minute spines along minutely crenulate distal margin.

Etymology. The species takes its name from the research vessel of New South Wales State Fisheries, the FRV *Kapala,* which has provided important collections of amphipods from the east coast of Australia.

Remarks. *Sheardella kapala* is closely related to *S. tangaroa*. The most significant morphological difference appears to be the well developed 2-articulate maxillary

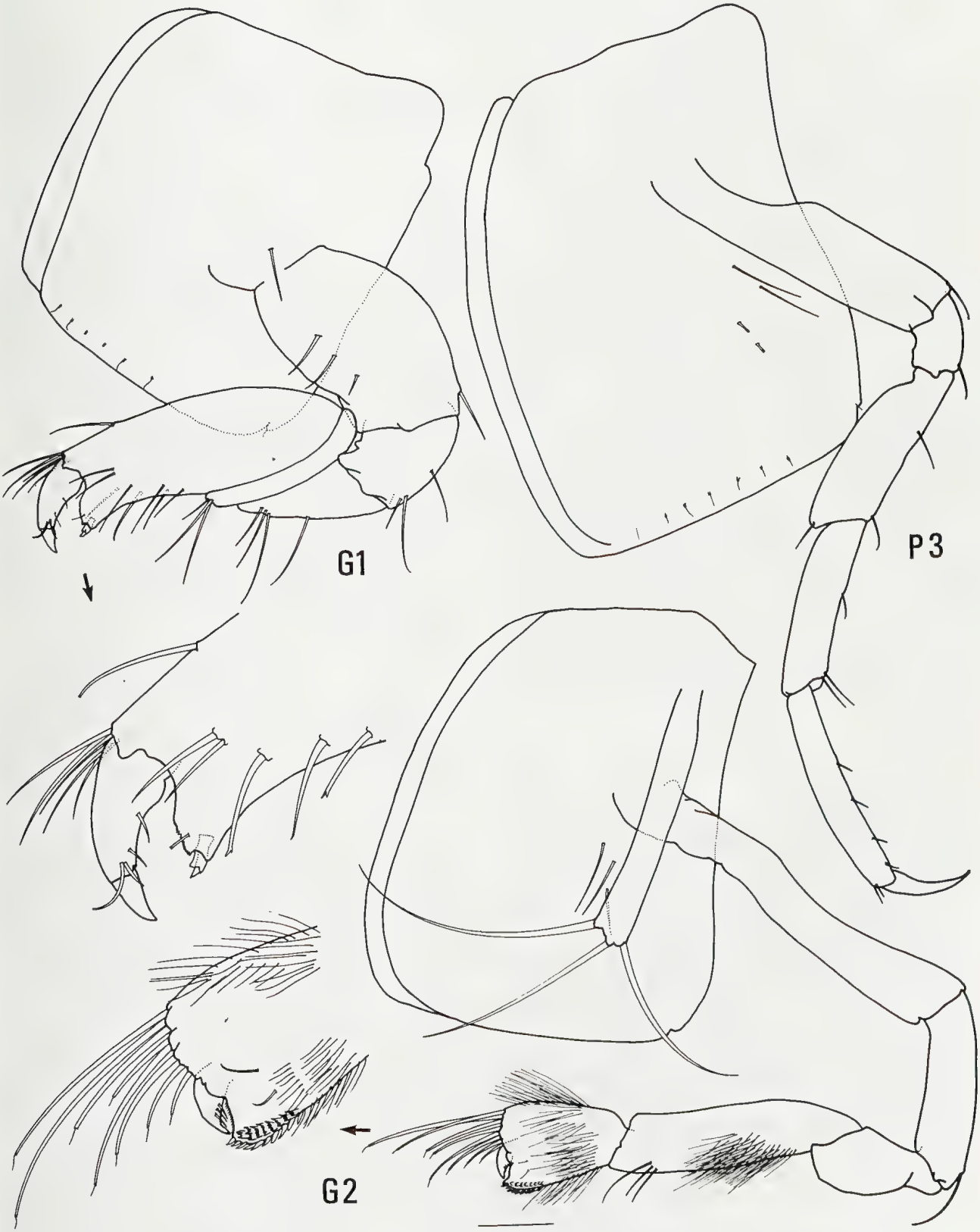

Fig. 5 *Sheardella tangaroa* n.gen. n.sp., holotype, female, 4.0 mm, E of Crib Point, Western Port, Victoria, Australia. Scale represents 0.1 mm.

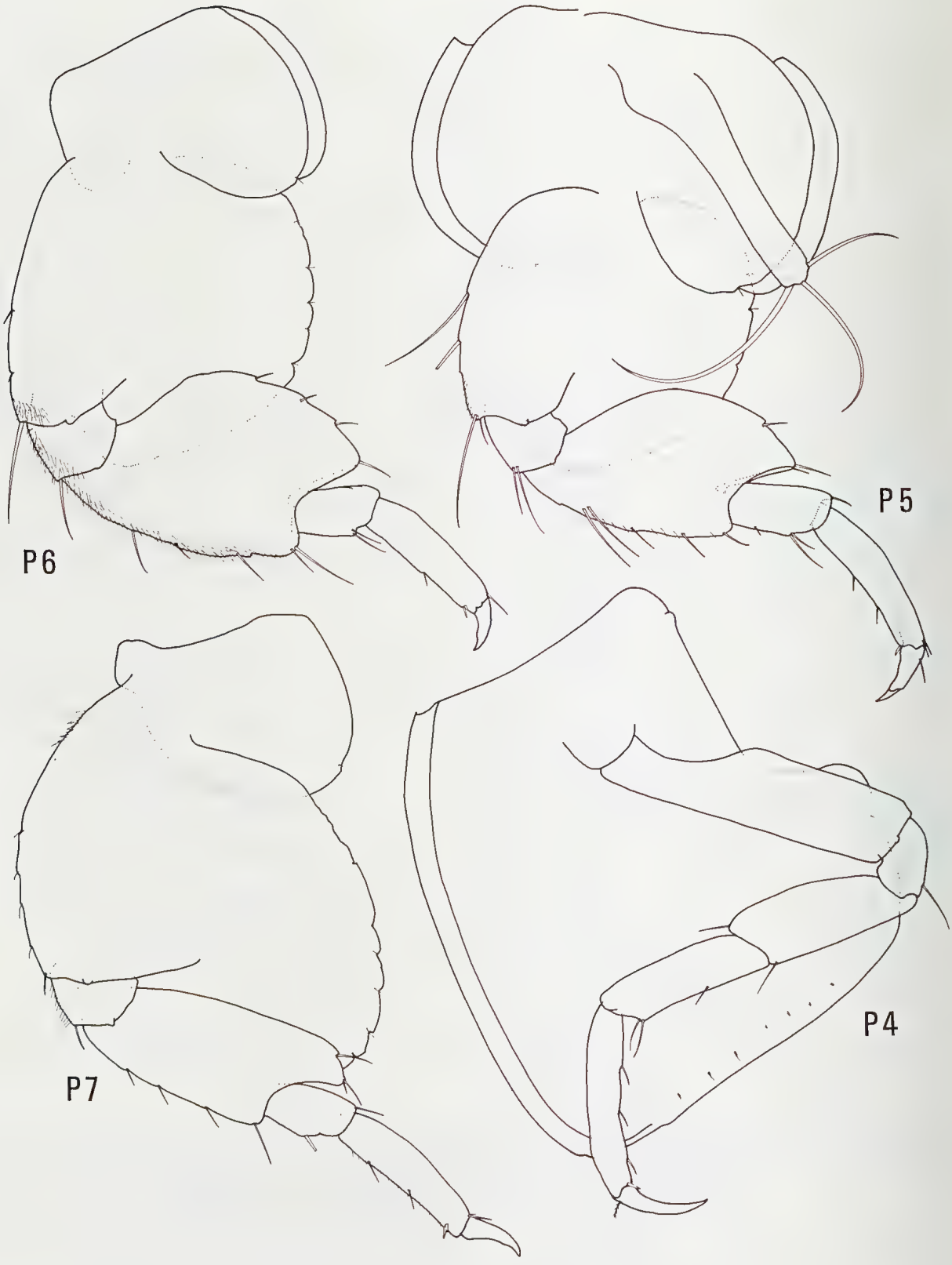

Fig. 6 *Sheardella tangaroa* n.gen. n.sp., holotype, female, 4.0 mm, E of Crib Point, Western Port, Victoria, Australia. Scale represents 0.1 mm.

palp of *S. kapala*. *Sheardella kapala* appears to be confined to the continental shelf whereas *S. tangaroa* inhabits shallow bays.

Distribution. *Sheardella kapala* is known from off Port Jackson, New South Wales, Australia, in 66 to 92 m depth and from Bass Strait in 60 m depth.

Sheardella tangaroa n.sp.

Figs 4–6

Type-material. HOLOTYPE, female, 4.0 mm, NMV J1694, Crib Point, Western Port, Victoria, Australia, 38°19.7'S 145°13.82'E, Smith-McIntyre grab, sand, 14 m, Marine Studies Group, Fisheries and Wildlife Department, Ministry for Conservation, Victoria, 22 March 1965, CPBS Station 33N. One PARATYPE, NMV J1691, as for holotype except: 38°22.00'S 145°13.38'E, shelly gravel, 3 m, 17 March 1965, CPBS Station 11S. Two PARATYPES, NMV J1692, as for holotype except: 38°21.33'S 145°13.64'E, fine sand/mud, 15 m, 8 April 1965, CPBS Station 31S. One PARATYPE, NMV J1969, as for holotype except: 38°20.94'S 145°13.62'E, fine sand/mud, 15 m, 29 March 1965, CPBS Station 31N. One PARATYPE, NMV J1698, as for J1692 except August 1967. One PARATYPE, NMV J1699, as for holotype except 38°20.83'S 145°13.49'E, sandy gravel, 13 m, 23 March 1965, CPBS Staton 32N. One PARATYPE, AM P34113, as for holotype except: 38°20.94'S 145°14.08'E, muddy sand, 16 m, 30 March 1965, CPBS Station 51N. One PARATYPE, AM P34114, Western Port, Victoria, Australia, 38°25.80'S 145°21.52'E, Smith-McIntyre grab, sand, 10 m, Marine Studies Group, Ministry for Conservation, Victoria, 26 November 1973, WBES Station 1732.

Diagnosis. Maxilla 1, palp reduced, 1-articulate. Gnathopod 1, palm convexly transverse. Gnathopod 2, article 5 almost 4 times as long as broad, palm concavely transverse. Peraeopods 5 and 6, article 4 as long as broad, moderately expanded posteriorly.

Description. Holotype female, 4.0 mm. *Antenna 1*: peduncular article 1 about 1.5 times as long as articles 2 and 3 combined, peduncle about 2.5 times as long as flagellum; fagellum 7-articulate; accessory flagellum 2-articulate. *Antenna 2* subequal in length to antenna 1; flagellum 5-articulate.

Mandible: incisor broad with smooth cutting edge; 3 well-developed accessory spines and a row of setae; palp attached about midway along dorsal margin, articles 2 and 3 slender; article 2 slightly longer than article 3, with 1 mediodistal seta; article 3 covered in minute hairs, with 5 terminal setae. *Maxilla 1*: inner plate small, narrow, subquadrate, with 1 large plumose seta and several small setae terminally; outer plate with 11 spine-teeth in a 7/4 formula, and a row of short stout setae; palp small, 1-articulate. *Maxilla 2* slender; inner plate with 4 terminal setae; outer plate with about 15 mediodistal setae. *Maxilliped*: inner plates reduced, each with 3 apical setae; outer plates large, subovate, reaching beyond end of 4-articulate palp.

Gnathopod 1 subchelate, large, coxa subquadrate; article 6 large, about 2.3 times as long as broad, with a complex spine defining convex palm; dactyl overreaching palm. *Gnathopod 2* minutely subchelate; article 5 almost 4 times as long as broad. Article 6 with concavely transverse palm and a row of about 8 serrate spines along posterodistal margin.

Peraeopods 3 and *4* similar except coxa 4 with well developed posteroventral lobe; article 4 shorter than article 6, anterodistal margin of article 4 not overlapping article 5. *Peraeopods 5* and *6*: article 2 about as broad as long with evenly rounded posterior margin; article 4 large, about as long as broad, moderately expanded posteriorly. *Peraeopod 7*: article 2 about as long as broad, posterior margin evenly rounded, crenulate; article 4 narrow, posterior margin oblique with 2 posterodistal setae.

Uropod 1: peduncle longer than rami and bearing 3 dorsal spines; outer ramus slightly longer than inner ramus, neither bearing spines. *Uropod 2* shorter than uropod 1; rami subequal in length, neither bearing spines. *Uropod 3* uniramous; peduncle subequal in length to 2-articulate ramus.

Etymology. This species takes its name from the research vessel of the New Zealand Oceanographic Institute, the RV *Tangaroa*, which has provided important collections of amphipods from the east coast of Australia.

Remarks. *Sheardella tangaroa* is related to *S. kapala*, the only other species in the genus, in the ways outlined under that species.

Distribution. *Sheardella tangaroa* is known only from Western Port, Victoria, Australia, where it has been collected on substrates ranging from sandy mud to shelly gravel in depths of 3 to 15 m.

Drummondia n.gen.

Diagnosis. Antenna 1, flagellum with fused proximal articles bearing rows of aesthetascs in adult male and female. Mandibles with incisor dorsodistal; lacinia mobilis absent; accessory spines absent; an elongate serrate blade (lamina dentata) present. Maxilla 1 slender, elongate; inner plate small, subquadrate with small terminal seta; outer plate with 11 short sculptured spine-teeth, (all sculptured); palp absent. Maxilla 2 with long, thin, tapering plates; outer plate longer, with medial and terminal setae; inner plate with several terminal setae. Maxilliped, inner plates small, with several apical setae; outer plates large, reaching beyond end of 4-articulate palp. Gnathopod 1 chelate or parachelate; palm defined by a complex spine. Coxa 4 with well-developed posteroventral lobe. Peraeopods 5 and 6, article 4 expanded posteriorly with moderately developed posteroproximal shoulder. Peraeonite 5 with small posterodorsal tooth. Uropod 3 biramous, inner ramus reduced.

Type-species. *Drummondia corinellae* n.sp.

Etymology. The genus *Drummondia* is named in honour of Mrs Margaret Drummond, now retired from the Marine Studies Group, Fisheries and Wildlife Department, Victoria, and the Museum of Victoria,

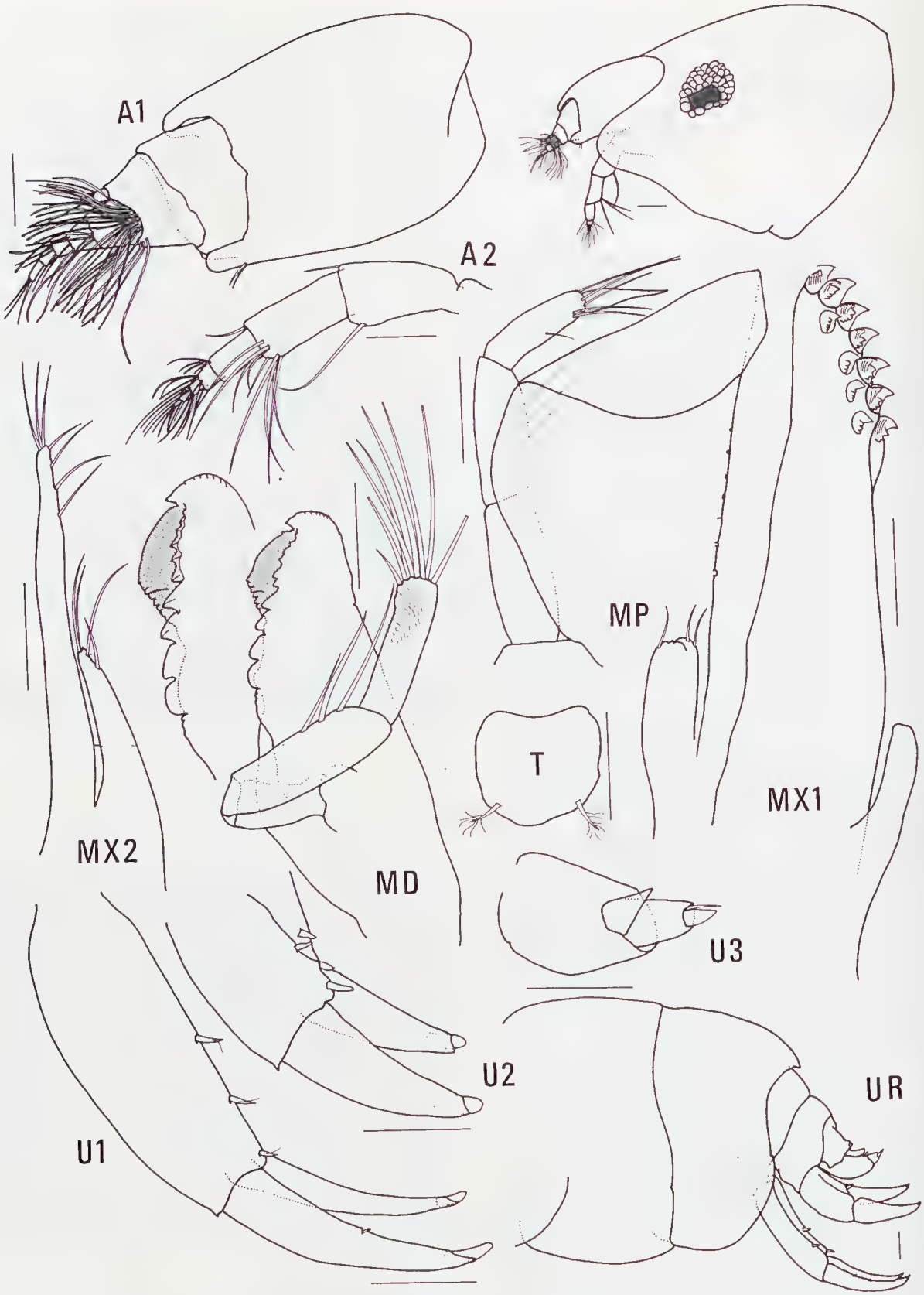

Fig. 7 *Drummondia corinellae* n.gen. n.sp., holotype, female, 6.3 mm, Crib Point, Western Port, Victoria, Australia. Scale represents 0.1 mm.

Fig. 8 *Drummondia corinellae* n.gen. n.sp., holotype, female, 6.3 mm, Crib Point, Western Port, Victoria, Australia. Scale represents 0.1 mm.

Melbourne, in recognition of her great contribution to the systematics of Australian Amphipoda.

Remarks. *Drummondia* differs from other pachynid genera in the reduced inner ramus of uropod 3 and in having a serrate blade on the mandibles. A structure similar to this occurs in some anthuridean isopods and is known as a lamina dentata. According to Dr Brian Kensley (pers. comm.) the lamina dentata is formed by the fusion of the accessory spines. The accessory spines of *Sheardella* are broad and their fusion could produce a structure such as the serrate blade found in *Drummondia*.

Drummondia is most closely related to *Prachynella*. Both genera have fused proximal articles bearing rows of aesthetascs on the flagellum of antenna 1 in adult males and females. Both genera have lost the lacinia mobilis and accessory spines on the mandible and the palp on maxilla 1 and both genera have a small dorsal tooth on peraeonite 5.

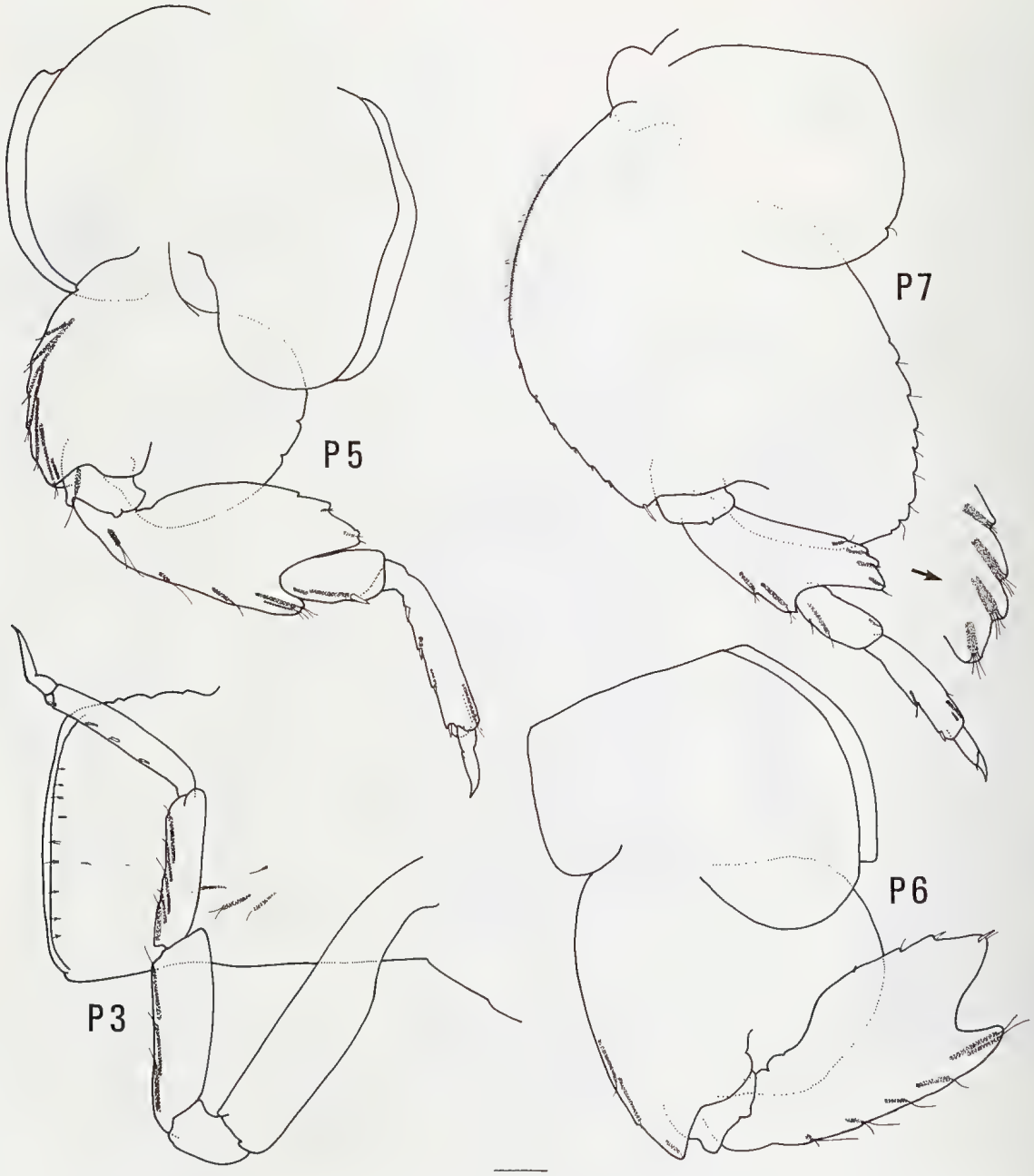

Fig. 9 *Drummondia corinellae* n.gen. n.sp., holotype, female, 6.3 mm, Crib Point, Western Port, Victoria, Australia. Scale represents 0.1 mm.

Drummondia contains 2 species, *D. corinellae* and *D. parviramus,* which inhabit the shallow bays of eastern Australia.

Drummondia corinellae n.sp.

Figs 7–9

Type-material. HOLOTYPE, ovigerous female, 6.3 mm, NMV J1690, Crib Point, Western Port, Victoria, Australia, 38°21′S 145°14′E, Smith-McIntyre grab sample, 11 m, Marine Studies Group, Fisheries and Wildlife Department, Ministry for Conservation, Victoria, 12 October 1964, CPBS Station B4. One PARATYPE, NMV J1693, as for holotype except: 38°20.83′S 145°13.49′E, sandy gravel, 13 m, 23 March 1965, CPBS Station 32N. Two PARATYPES, AM P34115, Western Port, Victoria, Australia, 38°26.64′S 145°18.79′E, Smith-McIntyre grab sample, sand, 14 m, Marine Studies Group, Ministry for Conservation, Vicoria, 26 November 1973, WBES Station 1730.

Additional material examined. Two specimens, NMV J1695, as for holotype except: 38°21.48′S 145°13.85′E, coarse sand, 15 m, 24 March 1965, CPBS Station 41S. One specimen, NMV J1696, as for holotype except: 38°20.94′S 145°14.08′E, muddy sand, 16 m, 30 March 1965, CPBS Station 51N.

Diagnosis. Gnathopod 1 chelate, article 6, 2.75 times as long as broad, complex spine defining palm. Peraeopods 3 to 7 with setae encased in sheaths. Peraeopods 5 and 6, article 4 weakly expanded posteriorly, dactyls slender.

Description. Holotype, ovigerous female, 6.3 mm. Eyes present, lateral cephalic lobe subacute. *Antenna 1*: peduncular article 1 longer than rest of antenna, article 1 produced dorsally and ventrally about halfway along article 2; accessory flagellum 2-articulate and shorter than article 1 of flagellum; flagellum 5-articulate, article 1 about as broad as long and bearing a large group of aesthetascs, remaining articles setose. *Antenna 2* slender, about as long as antenna 1; articles 4 and 5 each twice as long as broad and subequal in length; flagellum 5-articulate.

Mandible: incisor dorsodistal; lacinia mobilis absent; left lamina dentata with about 9 serrations; palp article 2 slightly longer than article 3 with 3 large mediodistal setae; article 3 with a group of 8 large apical setae. *Maxilla 1*: inner plate small, subquadrate; outer plate with 11 small well-developed spine-teeth; palp absent. *Maxilla 2* slender, elongate; inner plate about half length of outer plate with 2 subapical and 2 apical setae; outer plate with 4 subapical and 3 apical setae. *Maxilliped*: inner plates small, each with a few apical setae; outer plates large, subovate, reaching beyond end of 4-articulate palp.

Gnathopod 1 chelate; coxa subquadrate; article 6 large, 2.75 times as long as broad, palm minutely rugose, defined by a complex spine (damaged), posterior margin with 5 strong setae; dactyl stout, reaching corner of palm. *Gnathopod 2* minutely subchelate; article 5 more than twice as long as article 6; article 6 subquadrate, nearly twice as long as broad, palm transverse, posterodistal margin with a row of 11 serrate spines.

Peraeopod 3: coxa longer than broad, subquadrate; articles 4 and 6 subequal in length and slightly longer than article 5; articles 4 and 5, posterior margin with small setae encased in elongate sheaths; article 6 with shorter but similar sheaths. *Peraeopod 4* similar to peraeopod 3 except coxa 4 with a well-developed posteroventral lobe. *Peraeopod 5*: article 2 with elongate sheaths along anterior margin, posterior margin evenly rounded; article 4 large, anterior margin with elongate sheaths encasing short setae, posterior margin convex, not strongly expanded, with several short sheaths posterodistally; article 6 slender, 5 times as long as broad, with short sheaths encasing setae along anterior margin and 2 elongate sheaths posterodistally. *Peraeopod 6*: article 2, anterior margin with 3 elongate sheaths, posterior margin strongly expanded and evenly rounded; article 4 large, expanded posteriorly, anterior margin with elongate sheaths. *Peraeopod 7*: article 2 larger than article 2 of peraeopods 5 and 6, subovate posteriorly with slightly crenulate margin; article 4 expanded posterodistally with 4 sheathed setae, anterior margin with 2 sheathed setae; article 6, 4 times as long as broad with 1 sheathed seta on anterior margin and 2 posterodistally.

Uropod 1: peduncle longer than rami, with 3 dorsodistal spines; outer ramus slightly longer than inner ramus, with small mid-dorsal spine. *Uropod 2* shorter than uropod 1; outer ramus slightly longer than inner ramus. *Uropod 3* small; peduncle longer than rami; inner ramus about half length of outer ramus. *Telson* entire, slightly broader than long with 2 sensory setae on posterior margin.

Etymology. The species is named after the town of Corinella, the oldest permanent settlement on the shores of Western Port, Victoria.

Remarks. *Drummondia corinellae* is easily distinguished from the only other species in the genus, *D. parviramus,* by its larger size, the shorter dactyl of gnathopod 1 and the sheathed setae on the peraeopods.

Distribution. *Drummondia corinellae* is known from sandy gravel to muddy sand bottoms in 13–16 m depth in Western Port, Victoria, Australia.

Drummondia parviramus n.sp.

Figs 10–12

Type-material. HOLOTYPE, 4.8 mm, AM P33838; one PARATYPE, AM P33839; Halifax Bay, Queensland, Australia, 19°10′S 146°44′E, 5 m, January 1978, Station 78-1-G.

Diagnosis. Gnathopod 1 parachelate, article 6 about twice as long as broad, complex spine defining palm. Setae on peraeopods not encased in sheaths. Peraeopods 5 and 6, article 4 strongly expanded posteriorly, dactyls stocky.

Description. Holotype, 4.8 mm. Eyes present, lateral cephalic lobe broadly rounded. *Antenna 1*: peduncular article 1 longer than rest of antenna, produced dorsally and ventrally about halfway along article 2; accessory flagellum 2-articulate; flagellum 5-articulate, proximal articles fused, bearing rows of aesthetascs. *Antenna 2* slender, subequal in length to antenna 1; flagellum 4-articulate.

Mandible: left lamina dentata well developed, with 8 serrations, weakly developed on right side, with 2 serrations; palp with 2 mediodistal setae on article 2 and 6 terminal setae on article 3. *Maxilla 1*: inner plate small, tapering distally with 1 minute seta; outer plate with 11 short, sculptured spine-teeth in a 7/4 formula. *Maxilla 2*: inner plate short, about half length of outer plate with several apical setae; outer plate subquadrate with about 8 medial setae and 5 terminal setae. *Maxilliped*: inner plates small, each with an apical seta; outer plate large, subovate, reaching beyond end of 4-articulate palp.

Gnathopod 1 parachelate, article 6 about twice as long as broad, complex spine defining palm, dactyl overreaching palm. *Gnathopod 2* minutely subchelate; article 6 subquadrate, about 1.5 times as long as broad, palm convexly transverse, posterodistal margin with a row of about 10 serrate spines.

Peraeopods 3 and *4* similar except coxa 4 with well-developed posteroventral lobe with a sharply rounded posteroproximal corner; article 4 in both peraeopods slightly shorter than article 6 and not overlapping article

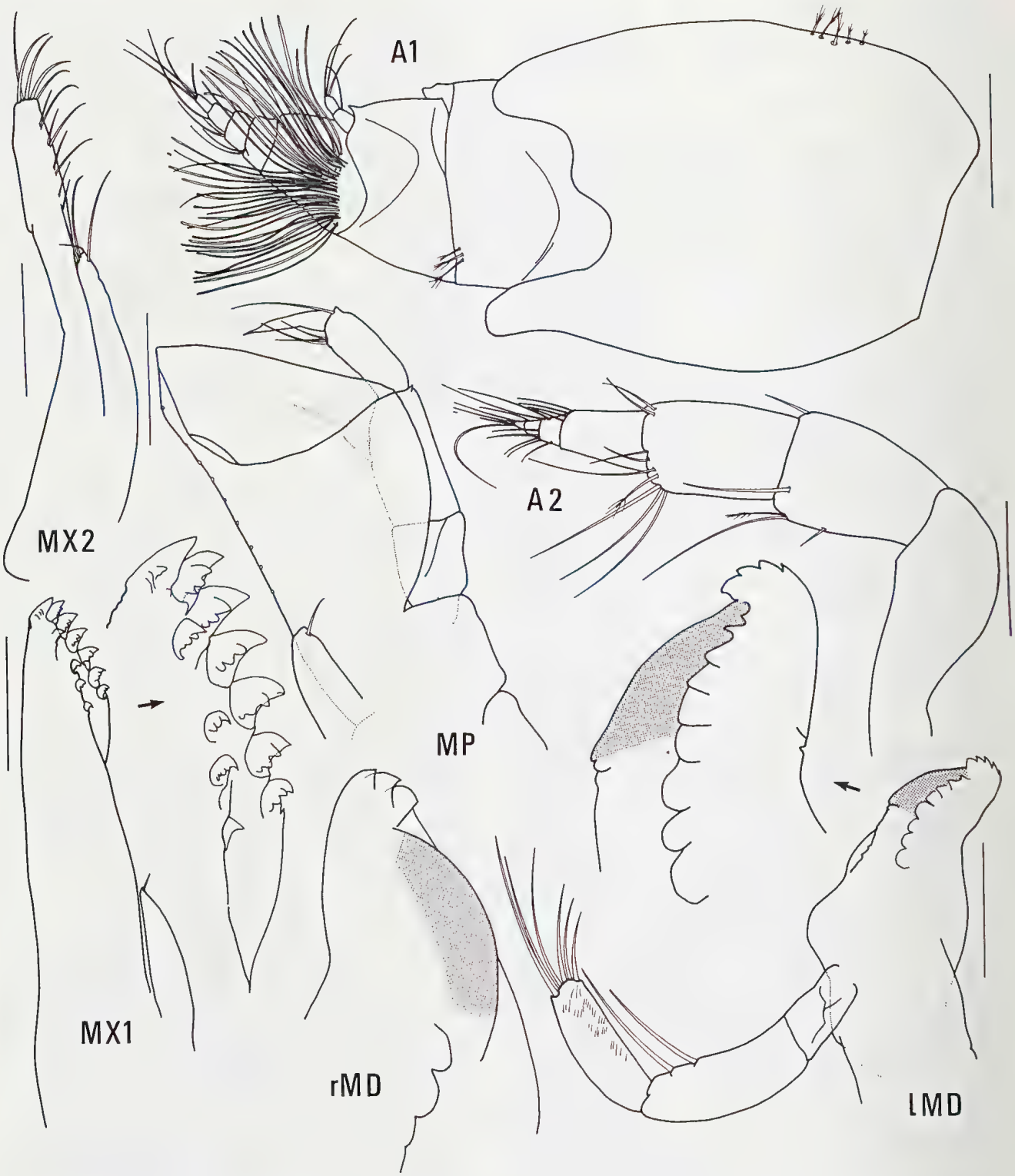

Fig. 10 *Drummondia parviramus* n.gen. n.sp., holotype, 4.8 mm; MX1 and MP, paratype; Halifax Bay, Queensland, Australia. Scales represent 0.1 mm.

Fig. 11 *Drummondia parviramus* n.gen. n .sp., holotype, 4.8 mm, Halifax Bay, Queensland, Australia. Scales represent 0.1 mm.

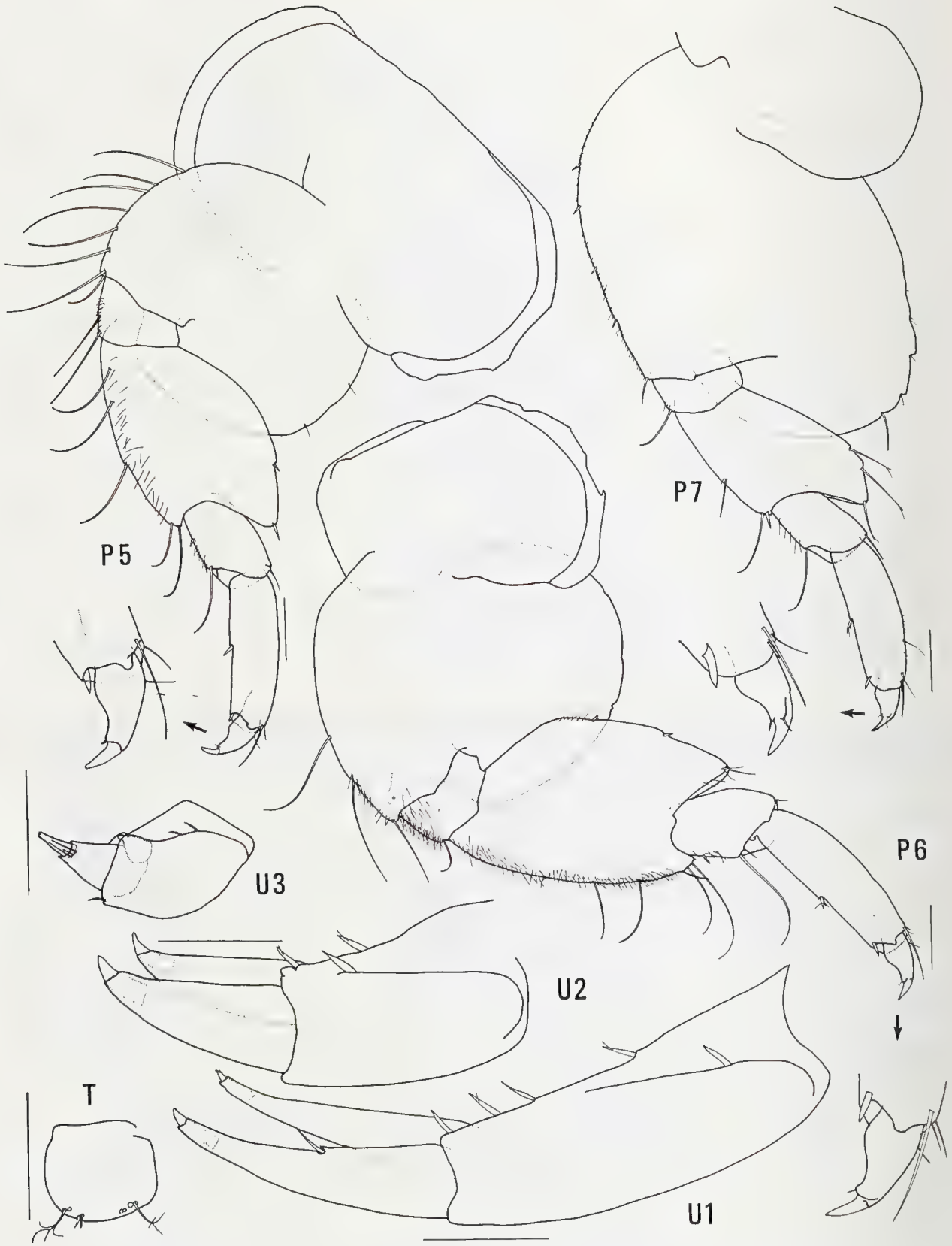

Fig. 12 *Drummondia parviramus* n.gen. n .sp., holotype, 4.8 mm, Halifax Bay, Queensland, Australia. Scales represent 0.1 mm.

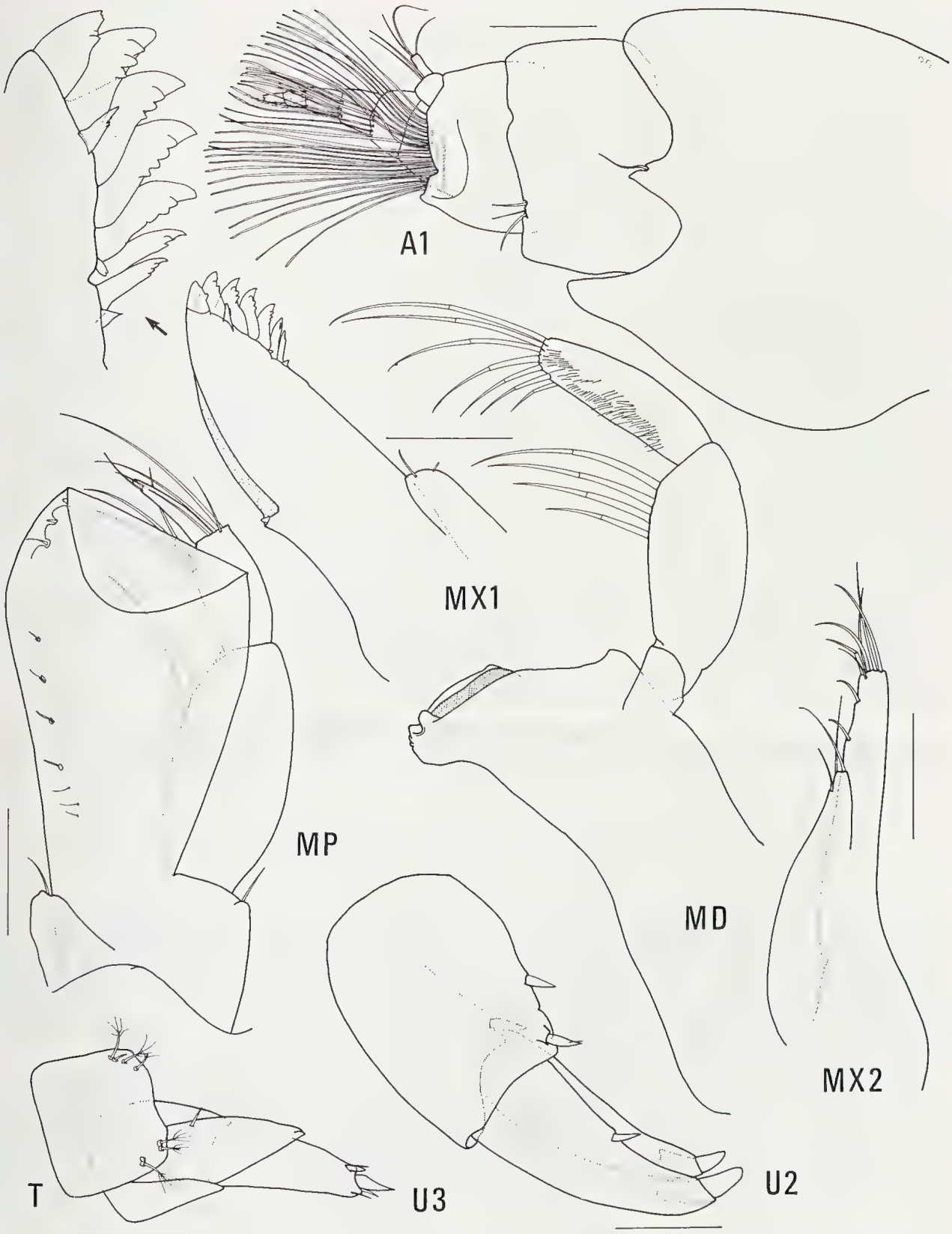

Fig. 13 *Prachynella lodo* J.L. Barnard, holotype, females 5.8 mm, San Mateo Point, California, USA. Scales represent 0.1 mm.

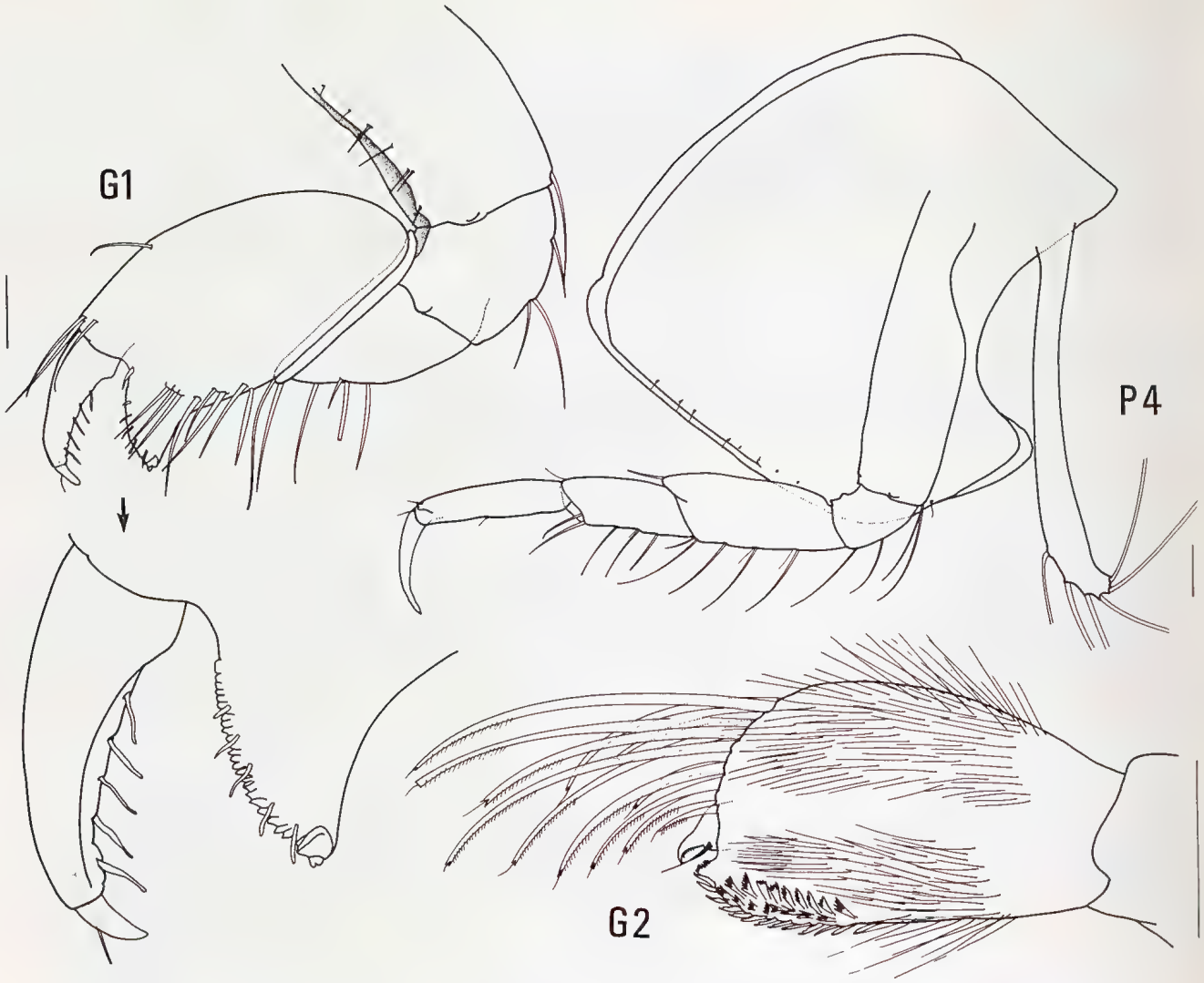

Fig. 14 *Prachynella lodo* J.L. Barnard, holotype, females 5.8 mm, San Mateo Point, California, USA. Scales represent 0.1 mm.

5 along anterodistal margin. *Peraeopod 5*: article 2 slightly broader than long, posterior margin evenly rounded, anterior margin with long setae; article 4 strongly expanded posteriorly with a broadly rounded posteroproximal shoulder; dactyl short, stocky. *Peraeopod 6*: article 2 slightly broader than long, posterior margin evenly rounded, anterior margin with several long distal setae; article 4 strongly expanded posteriorly with obtusely angled posteroproximal corner; dactyl short, stocky. *Peraeopod 7*: article 2 longer than broad, posterior margin straight with a broadly rounded posteroventral corner; article 4 with an oblique slightly convex posterior margin with 3 distal setae.

Uropod 1: peduncle longer than rami, with 5 dorsal spines; outer ramus slightly longer than inner ramus, with 1 mid-dorsal seta. *Uropod 2*: peduncle slightly longer than rami, with 3 dorsal spines; rami subequal in length. *Uropod 3* small, peduncle longer than 2-articulate outer ramus; inner ramus reduced. *Telson* entire, broader than long with 8 sensory setae along posterior margin.

Etymology. The specific name refers to the small rami of uropod 3.

Remarks. *Drummondia parviramus* differs from *D. corinellae* in the ways listed under that species. In a collection made by K. Sheard in 1944 from Spencer Gulf, South Australia (AM P33831–P33832) there are 3 reproductive males of a *Drummondia* species which is very similar to *D. parviramus*. There are subtle differences in the shapes of gnathopod 1 and peraeopods 5 to 7. But until females are available for study I am leaving it undescribed.

Distribution. *Drummondia parviramus* is known from two specimens from Halifax Bay, Queensland, Australia.

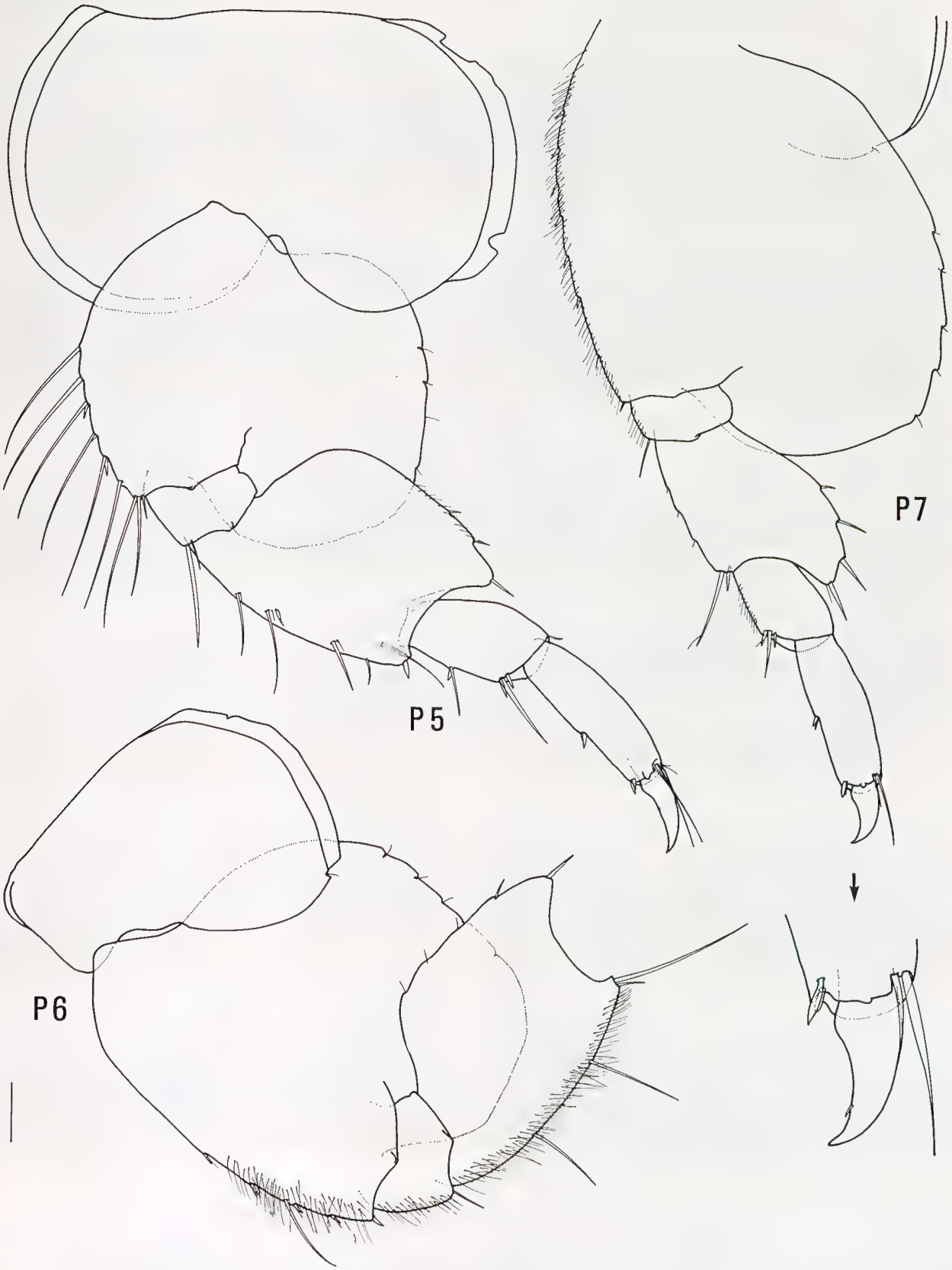

Fig.15 *Prachynella lodo* J.L. Barnard, holotype, females 5.8 mm, San Mateo Point, California, USA. Scale represents 0.1 mm.

Prachynella J.L. Barnard

Prachynella J.L. Barnard, 1964: 232.—1969a: 359.

Diagnosis. Antenna 1, flagellum with proximal articles fused and bearing rows of aesthetascs in male and female. Mandibles lacking lacinia mobilis and accessory spines. Maxilla 1, inner plate subquadrate with small terminal setae; outer plate with 8–10 sculptured spine-teeth; palp a minute article. Maxilla 2 with long, thin, tapering plates; outer plate with medial and terminal setae; inner plate with several terminal setae. Maxilliped, inner plates small, with an apical seta; outer plates large, reaching beyond end of 3-articulate palp. Gnathopod 1 chelate, palm defined by a complex spine. Coxa 4 with well-developed posteroventral lobe. Peraeopods 5 and 6, article 4 strongly expanded posteriorly with well-developed posteroproximal shoulder. Peraeonite 5 with small posterodorsal tooth. Uropod 3 biramous.

Type-species. *Prachynella lodo* J.L. Barnard, 1964 (original designation).

Remarks. *Prachynella* is most closely related to *Drummondia*, both genera having the characteristic small tooth on peraeonite 5. *Prachynella* differs from *Drummondia* in not having a lamina dentata on the mandible, in having fewer spine-teeth on maxilla 1 and in having a 3-articulate maxillipedal palp.

Prachynella contains two species, *P. lodo* known from southern California and *P. mediterranea* known from the Adriatic Sea. It is possible that the *Prachynella* specimens studied by J.L. Barnard (1964, 1967) represent several species.

Prachynella lodo J.L. Barnard, 1964

Figs 13–15

Prachynella lodo J.L. Barnard, 1964: 233, fig. 7.—1966a: 70; 1966b: 26; 1967: 69, figs 29, 30.

In the original description of *Prachynella lodo*, Barnard (1964) designated a holotype (AHF 5735) from station 4868, south-east of San Mateo Point, California, but he described and illustrated a specimen from Station 5193, locality not mentioned. Barnard (1967) republished the original plates and illustrated two other specimens which differed from the original specimen. I borrowed the holotype, which is illustrated below. The holotype differs from the specimen illustrated in Barnard (1964) in that the palm of gnathopod 1 is not as strongly produced distally and is defined by a complex spine, and the dorsal flange of peduncular article 1 is not strongly produced over article 2. There is some confusion between the figures and the text in Barnard (1967) but it appears that the holotype differs from the anoculate deep-sea specimen illustrated by Barnard (1967, fig. 30a-g) in having eyes and a shallow posterodorsal tooth on peraeonite 5 and it appears to differ from the shallow-water oculate form (fig. 30h-k) in having a complex tooth defining the palm of gnathopod 1. From the studies of Barnard (1964, 1967) it appears that several species of *Prachynella* occur along the Californian coast. The holotype of *P. lodo* is illustrated and diagnosed here. The large collection needs to be studied in detail to determine if there is more than one species in this material.

Material examined. HOLOTYPE female, 5.8 mm, AHF 5735, south-east of San Mateo Point on the California Coast, 33°17′35″N 117°31′00″W, 24 m, 20 February 1957, Station 4868. 1 specimen, Monterey Bay, California, 54 m, station 6426; 1 specimen Monterey Bay, California, 139 m, station 6471; 1 specimen, Santa Cruz Canyon, southern California, 459 m, station 6804; 1 specimen, Cedros Trench, Baja California, 27°38′N 115°16′W, 791–842 m, 2 January 1961, station 7234.

Diagnosis. Eyes present. Antenna 1, peduncular article 1 produced dorsally and ventrally about halfway along article 2. Maxilla 1, outer plate with 10 spine-teeth in a 7/3 formula. Gnathopod 1 chelate with a convex palm, defined by a complex spine. Peraeopod 5 with long setae along anterior margin of articles 2 to 5.

Remarks. *Prachynella lodo* and *P. mediterranea* appear to be closely related species even though they are widely separated geographically. The most significant difference between them is the number of spine-teeth on maxilla 1. The deepwater specimen from 791 m off southern California which J.L. Barnard (1967) studied may represent a third species in the genus.

Distribution. *Prachynella lodo* is known from numerous sites in southern California and Baja California from 10–791 m depth.

Prachynella mediterranea (Ruffo, 1975) n.comb.

Figs 16, 17

Pachychelium mediterraneum Ruffo, 1975: 440, figs 1–4.

Material examined. HOLOTYPE, 1.8 mm, MCSN slides 1341-1343, Central Adriatic Sea, 43°35′40″N 15°41′54″W, 160 m, 14 September 1972.

Diagnosis. Eyes absent. Antenna 1, article 1 of peduncle produced dorsally to end of peduncle and produced ventrally to end of article 2. Maxilla 1, outer plate with 8 spine-teeth in a 5/3 formula. Gnathopod 1 chelate with a straight palm defined by a complex spine. Peraeopod 5 without long setae along anterior margin of articles 2 to 5.

Remarks. *Prachynella mediterranea* is known from only one specimen in the Adriatic Sea but this record of a sculptured-toothed pachynid outside the Pacific Ocean suggests that more species await discovery in the deep-sea North and South Atlantic.

The Smooth-toothed Subgroup

Pachynus Bulycheva, 1955

Pachynus Bulycheva, 1955: 193.—Hurley, 1963: 30; J.L. Barnard, 1969a: 354.

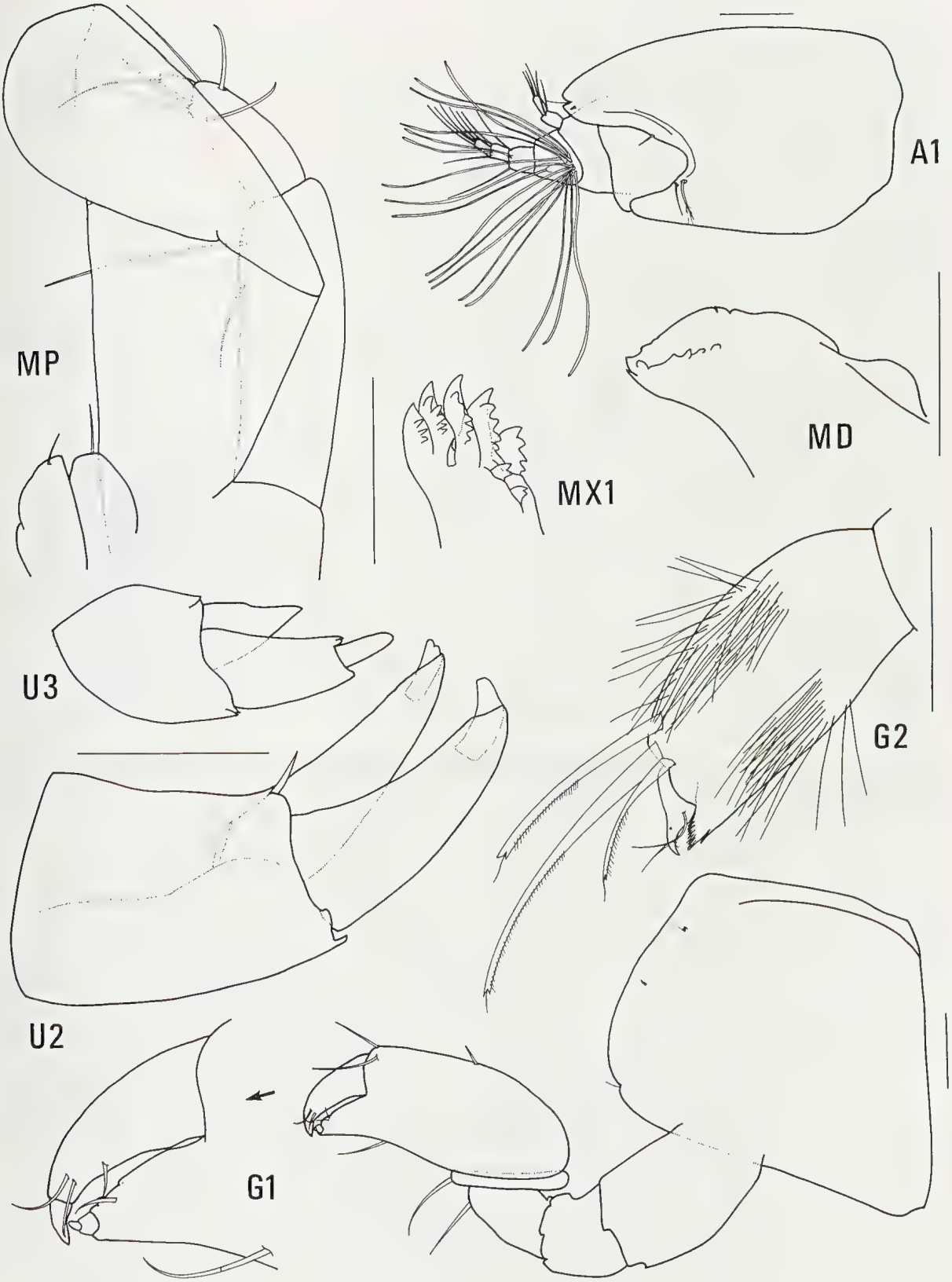

Fig. 16 *Prachynella mediterranea* (Ruffo), holotype, 1.8 mm, Central Adriatic Sea. Scales represent 0.5 mm.

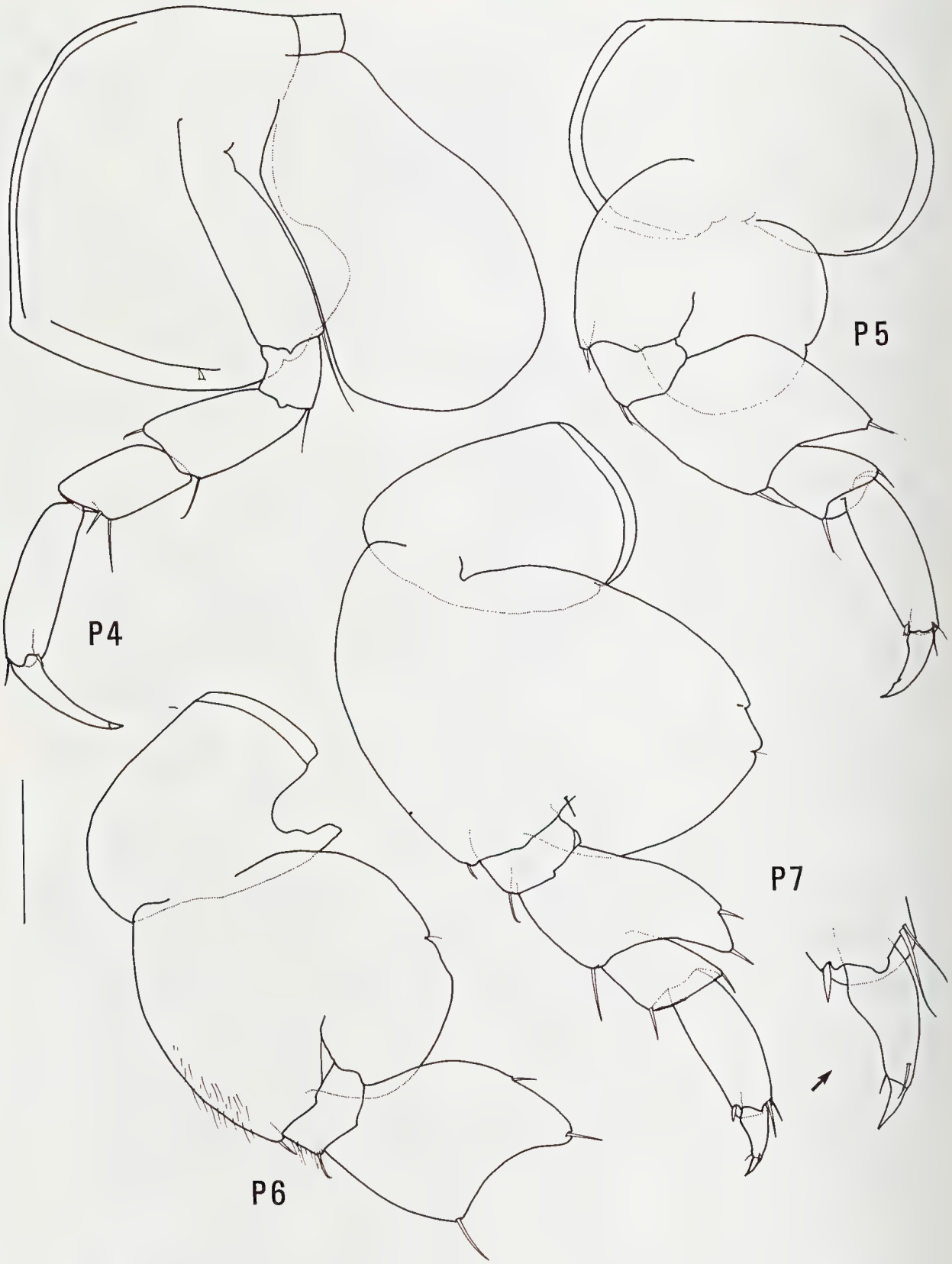

Fig. 17 *Prachynella mediterrane* (Ruffo), holotype, 1.8 mm, Central Adriatic Sea. Scale represents 0.1 mm.

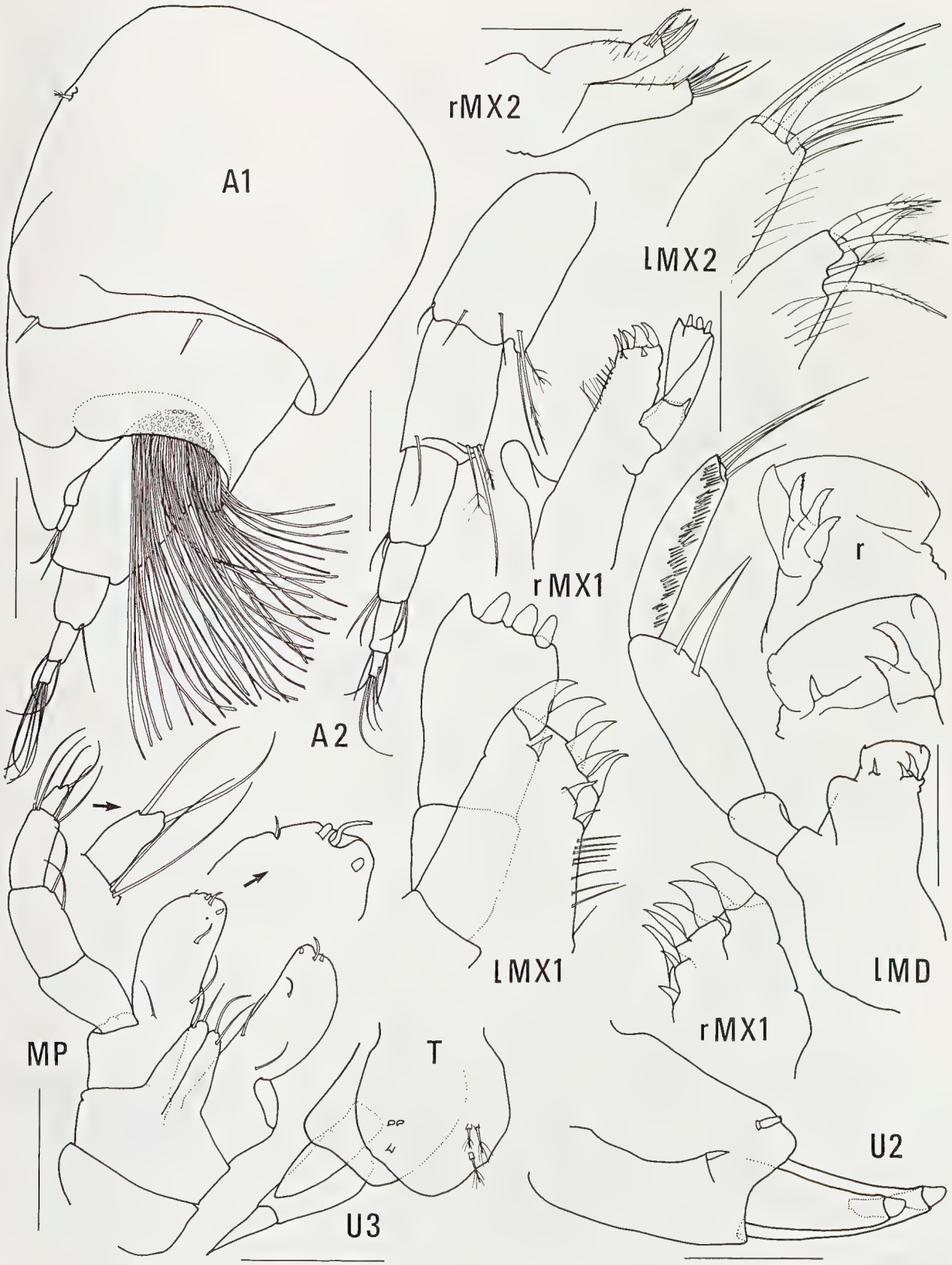

Fig. 18 *Pachynus pugilator* n.sp., holotype, 3.3 mm, Bass Strait, Australia. Scales represent 0.1 mm.

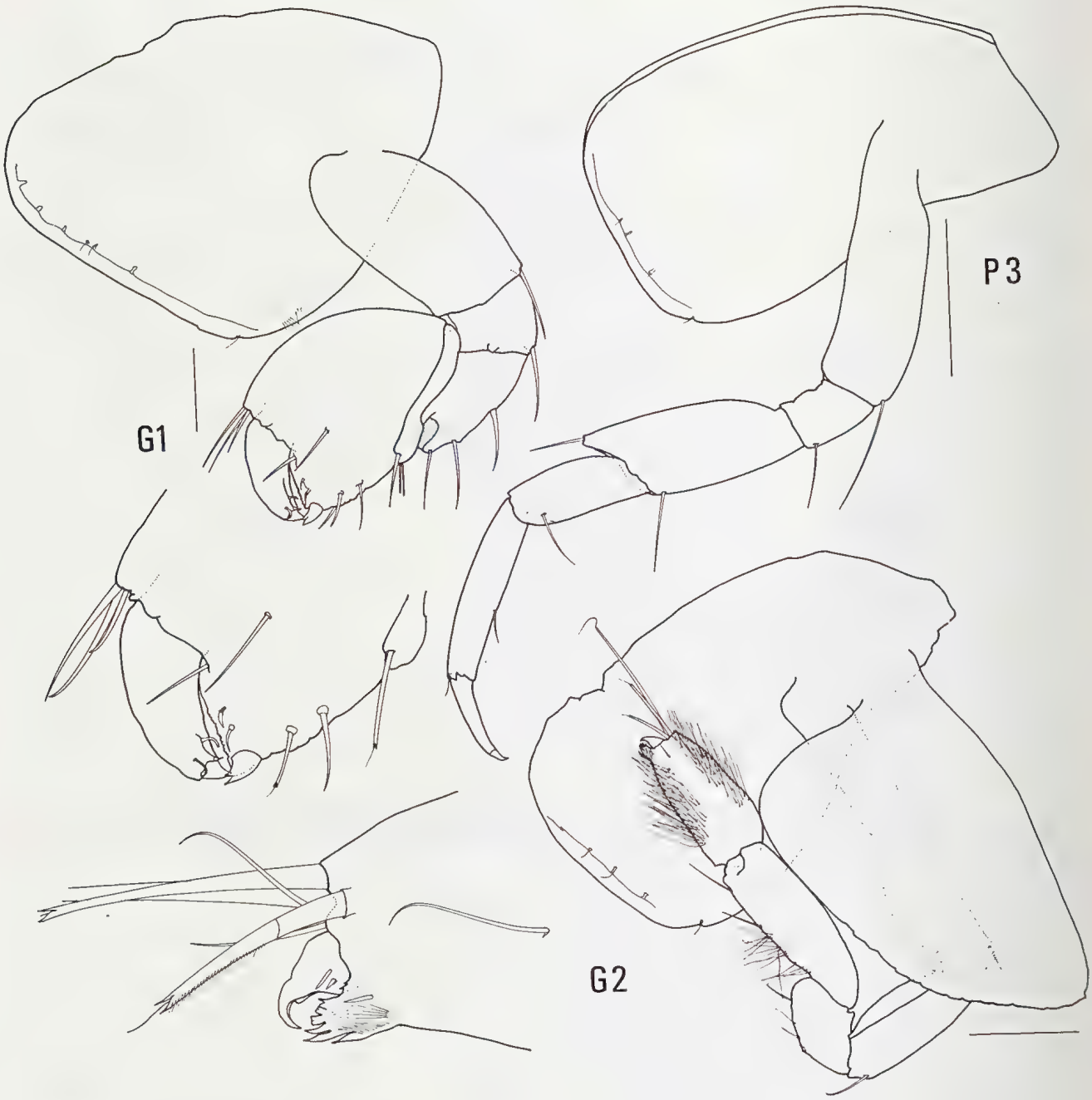

Fig. 19 *Pachynus pugilator* n.sp., holotype, 3.3 mm, Bass Strait, Australia. Scales represent 0.1 mm.

Diagnosis. Antenna 1, flagellum with fused proximal articles bearing rows of aesthetascs in male and female. Mandibles, left lacinia mobilis present; accessory spines on both mandibles. Maxilla 1, inner plate small, terminal setae absent; outer plate with 8 smooth spine-teeth in a 5/3 formula; palp 2-articulate with several terminal articulating spines. Maxilla 2 with short subquadrate plates bearing terminal setae. Maxillipeds, inner plates small to well-developed with several apical setae; outer plates not large, reaching end of second article of palp; palp 4-articulate, article 4 small. Gnathopod 1 subchelate to chelate, palm defined by a complex spine with a concave inner surface to receive tip of dactyl. Gnathopod 2, dactyl and palm minute. Coxa 4 with well-developed posteroventral lobe. Peraeopods 5 and 6, article 4 expanded posteriorly with well-developed posteroproximal shoulder. Peraeopods 5 to 7, article 5 with minute denticles along distal margin. Uropod 3 biramous.

Type-species. *Pachynus chelatum* Bulycheva, 1955 (original designation).

Remarks. Aside from the smooth spine-teeth the genus *Pachynus* shows little relationship to other

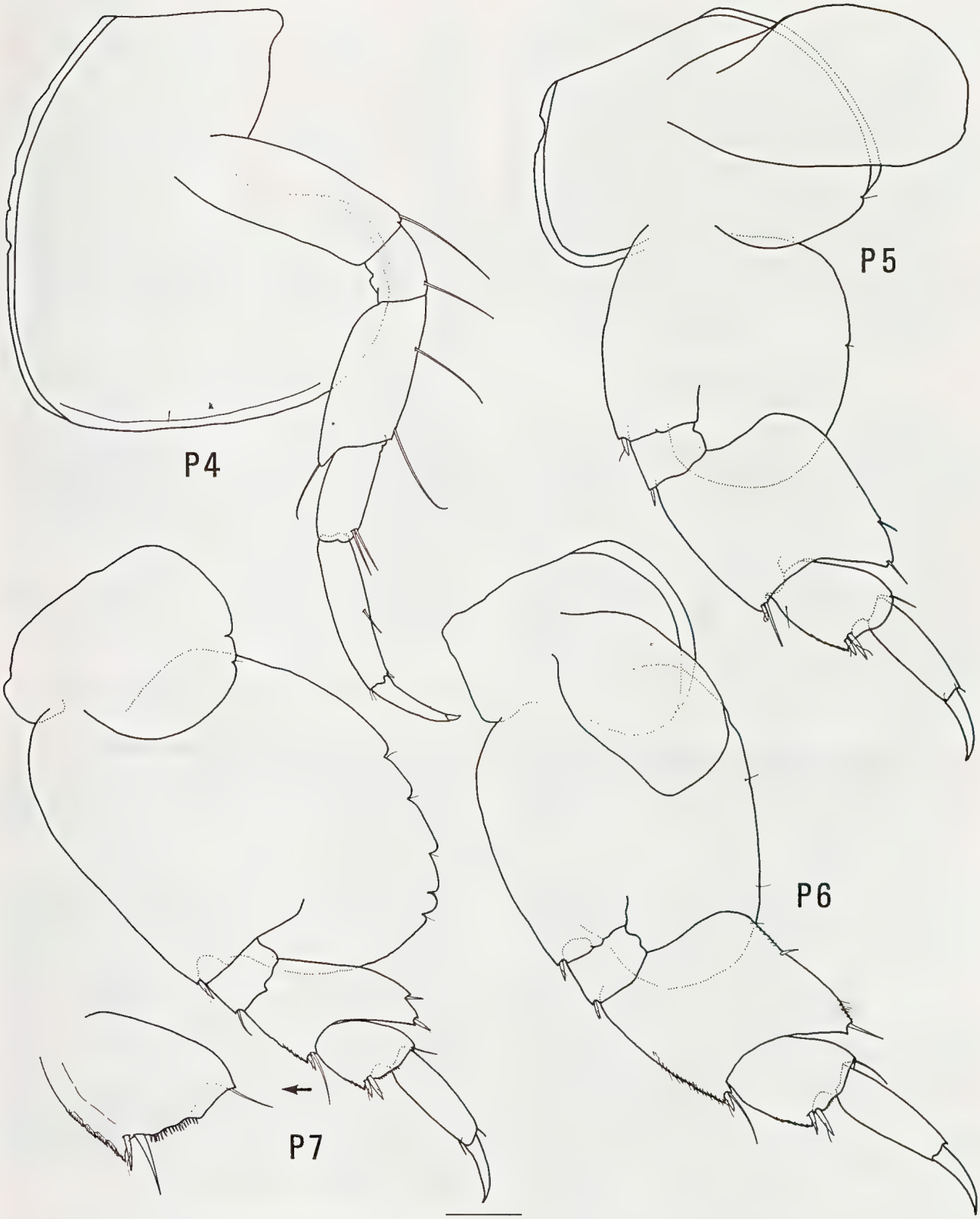

Fig. 20 *Pachynus pugilator* n.sp., holotype, 3.3 mm, Bass Strait, Australia. Scale represents 0.1 mm.

smooth-toothed genera. It differs from them in having fused proximal articles bearing rows of aesthetascs on the flagellum of antenna 1 in adult males and females, and in having terminal spines on the palp of maxilla 1 and a 5/3 spine-tooth formula on the outer plate. It also differs in having small outer plates and relatively large inner plates on the maxilliped, a peculiar character within the pachynids. *Pachynus* and *Figorella* both have a lacinia mobilis and accessory spines on the mandibles.

Pachynus is now known from the North and South Pacific Ocean. It contains four species: *P. chelatum* (Sea of Japan) and *P. barnardi* (continental shelf off southern California) from the North Pacific Ocean and *P. pugilator* and *P. denticulatum* (continental shelf off eastern Australia) from the South Pacific Ocean.

Pachynus pugilator n.sp.

Figs 18–20

Type-material. HOLOTYPE, 3.3 mm, NMV J3773, Bass Strait, Australia, 38°38.2'S 142°35.0'E, epibenthic sled, 59 m, Victorian Institute of Marine Sciences, Cruise 81-T-1 on RV *Tangaroa*, 20 November 1981, BSS Station 188.

Diagnosis. Antenna 1, accessory flagellum 2-articulate. Maxilla 1, outer plate with a 5/3 spine-tooth formula; palp with 3 terminal articulating spines. Gnathopod 1 subchelate; article 6 slightly produced posterodistally. Peraeopod 7, article 2 slightly longer than broad, posterior margin slightly convex, posteroventral corner subquadrate. Uropods not covered in minute denticles. Uropod 3, inner ramus shorter than article 1 of outer ramus.

Description. – Holotype, 3.3 mm. *Antenna 1*: peduncle massive, nearly twice as long as flagellum; flagellum 4-articulate, proximal articles fused, bearing rows of aesthetascs; accessory flagellum 2-articulate. *Antenna 2* slender, subequal in length to antenna 1; flagellum 4-articulate.

Mandible: left side with lacinia mobilis and 2 accessory spines, right side with 3 accessory spines; palp slender, articles 2 and 3 subequal in length, article 2 with 2 mediodistal setae, article 3 with 4 terminal setae. *Maxilla 1*: inner plate small, subquadrate, setae absent; outer plate with 8 spine-teeth in a 5/3 formula; palp broad, with 3 terminal spines. *Maxilla 2* short with subquadrate plates bearing terminal setae. *Maxilliped*: inner plates well developed, each with 2 apical setae; outer plates not well developed, reaching to distal end of palp article 2; palp 4-articulate, article 4 reduced.

Gnathopod 1 large, subchelate; coxa expanded distally; article 6 slightly longer than broad, slightly produced posterodistally; palm transverse, defined by complex spine hollowed to receive tip of dactyl. *Gnathopod 2* minutely chelate; article 5 longer than article 6; article 6 slightly more than twice as long as broad.

Peraeopod 4: coxa with broadly rounded posteroventral lobe; article 4 subequal in length to article 6 with anterior margin slightly produced along article 5. *Peraeopod 5*: article 2 about as long as broad, posterior margin broadly rounded; article 4 large, posteroproximal corner sharply rounded; *Peraeopod 6*: article 2 longer than broad, posterior margin straight; article 4 large, posteroproximal corner sharply rounded. *Peraeopod 7*: article 2 slightly longer than broad, posterior margin slightly convex, crenulate, posteroventral corner subquadrate; article 4, posterior margin oblique, slightly convex with 2 small posterodistal spines.

Uropod 2: peduncle slightly longer than rami; rami without marginal spines; inner ramus slightly shorter than outer ramus. *Uropod 3*: peduncle slightly shorter than 2-articulate outer ramus; inner ramus nearly as long as article 1 of outer ramus; rami without marginal spines. *Telson* entire, about as long as broad, rounded distally.

Etymology. The name *pugilator* alludes to the fist-like character of gnathopod 1.

Remarks. *Pachynus pugilator* appears to be the most plesiomorphic species in the genus, on the basis of the morphology of the maxilliped. It differs from other *Pachynus* species in the subchelate gnathopod 1. *Pachynus pugilator* shows a strong similarity to *P. chelatum* and *P. barnardi* in the morphology of the spine-teeth of maxilla 1.

Distribution. *Pachynus pugilator* is known at present from one specimen collected from 59 m depth in Bass Strait, Australia.

Pachynus chelatum Bulycheva, 1955

Figs 21–23

Pachynus chelatum Bulycheva, 1955: 194, fig. 1.—Hurley, 1963: 34; J.L. Barnard, 1969a: 354.

Material examined. One specimen, AM P33775, Sea of Japan, 88 m, N.I. Tarasov, 8 September 1932, Station xi-261, from the Zoological Institute, Academy of Sciences, USSR, catalogue number 5/2676.

Diagnosis. Antenna 1, accessory flagellum 2-articulate. Maxilla 1, outer plate with a 5/3 spine-tooth formula; palp with 3 terminal articulating spines. Gnathopod 1 chelate; article 6 moderately produced posterodistally. Peraeopod 7, article 2 about as long as broad, posterior margin and posteroventral corner gently rounded. Uropods not covered in minute denticles. Uropod 3, inner ramus slightly longer than article 1 of outer ramus.

Remarks. *Pachynus chelatum* is most closely related to *P. barnardi* from which it differs principally in the structure of articles 2 and 4 of peraeopods 5 to 7.

Distribution. *Pachynus chelatum* is known from the Sea of Japan in 88 to 125 m depth.

Pachynus barnardi Hurley, 1963

Fig. 24

Pachynus barnardi Hurley, 1963: 31, figs 6, 7.—J.L. Barnard, 1966a: 70; 1966b: 26; 1969b: 218, figs 25a-c; 1971: 44.
Pachynus sp. J.L. Barnard, 1964: 232.

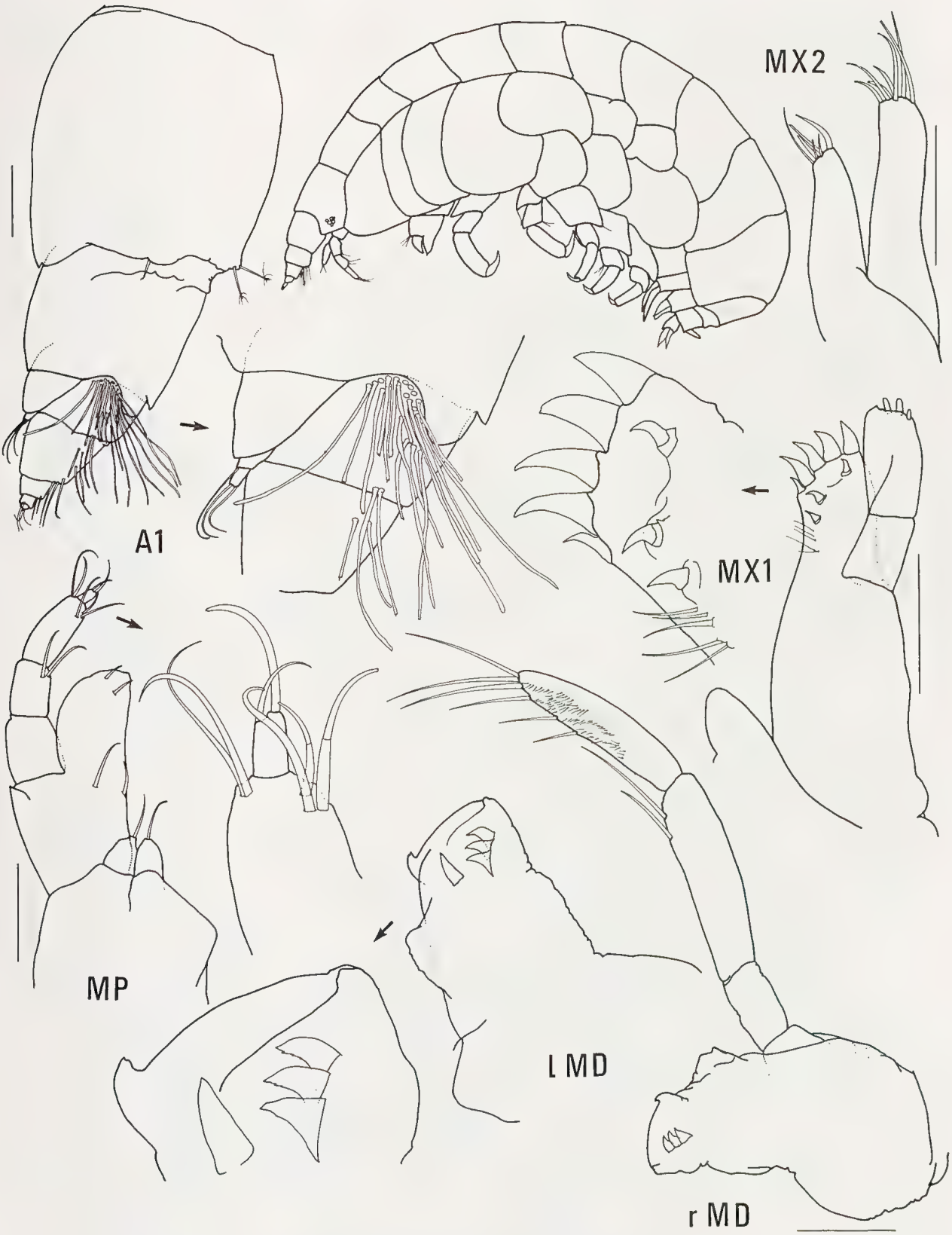

Fig. 21 *Pachynus chelatum* Bulycheva, Sea of Japan. Scales represent 0.1 mm.

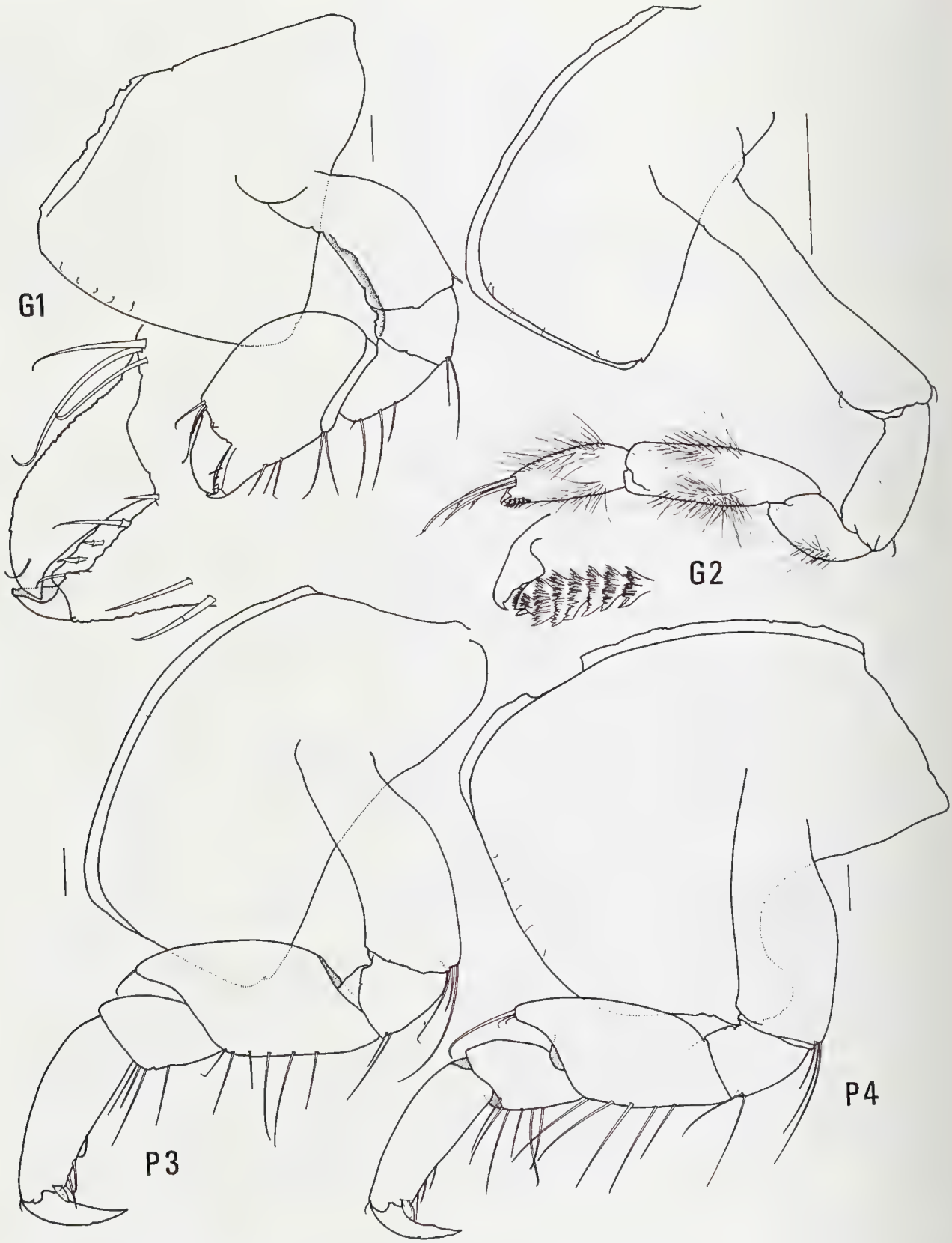

Fig. 22 *Pachynus chelatum* Bulycheva, Sea of Japan. Scales represent 0.1 mm.

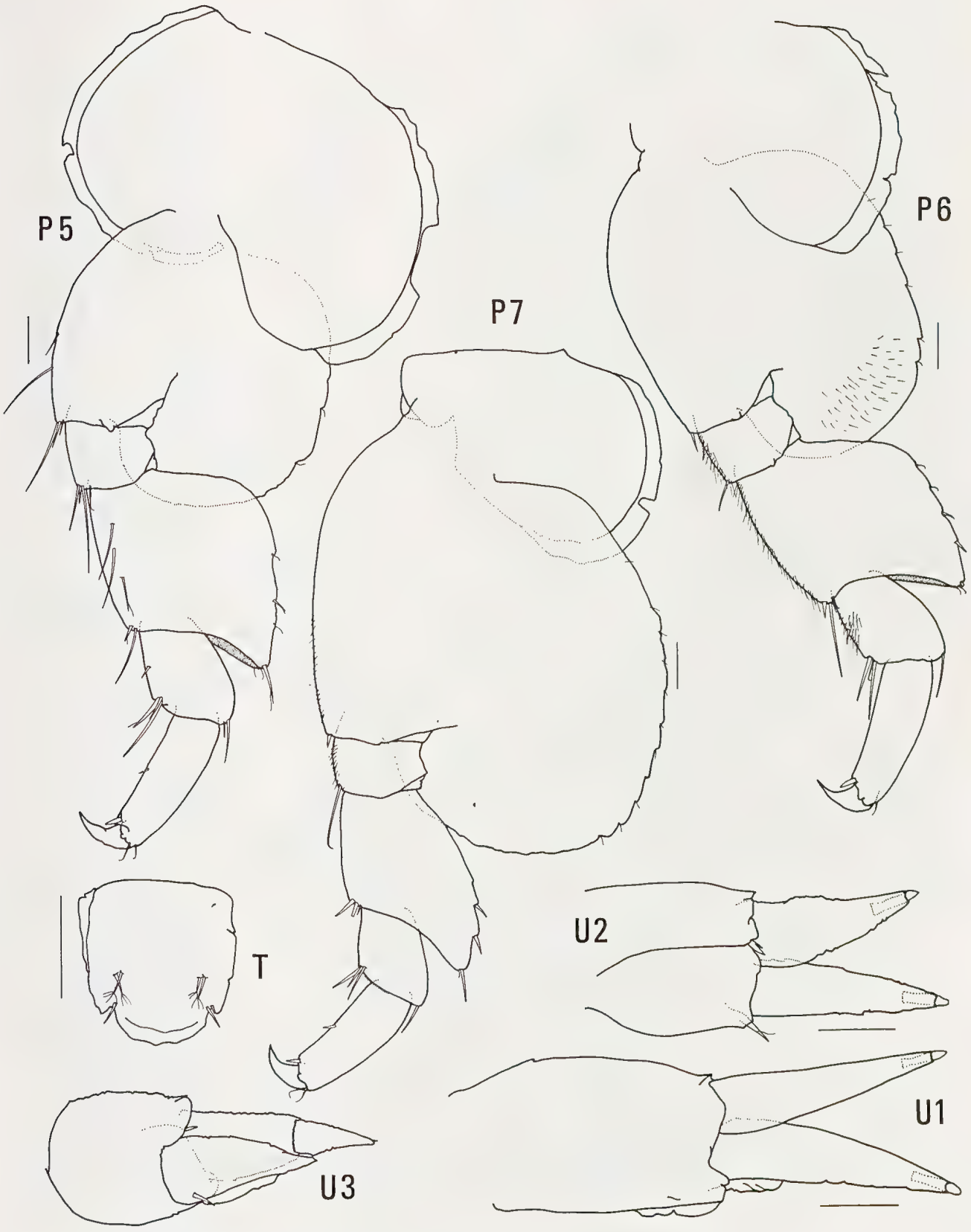

Fig. 23 *Pachynus chelatum* Bulycheva, Sea of Japan. Scales represent 0.1 mm.

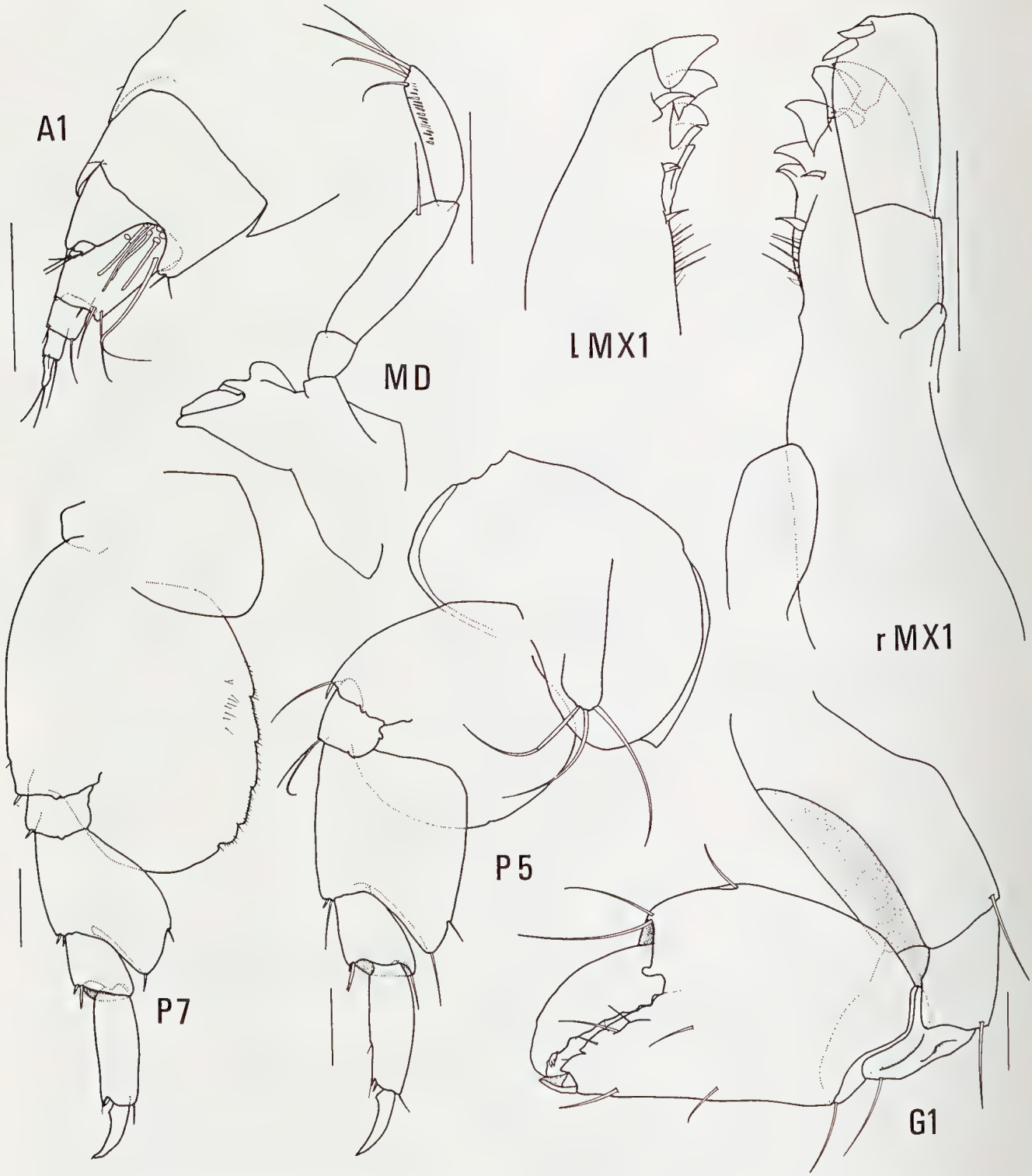

Fig. 24 *Pachynus barnardi* Hurley, holotype, W of Manhattan Beach, Los Angeles County, California, USA. MX scale represents 0.05 mm, other scales represent 0.1 mm.

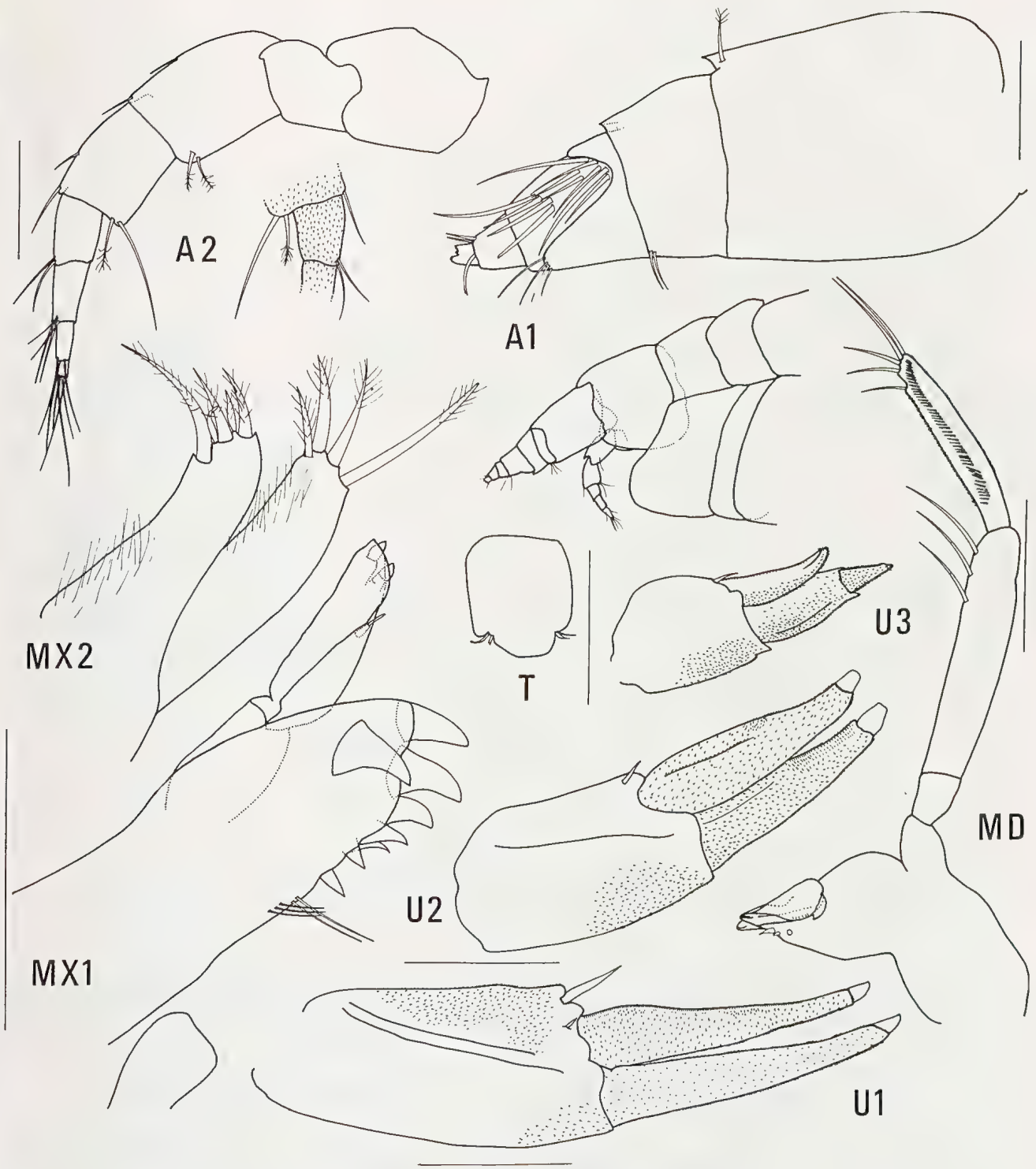

Fig. 25 *Pachynus denticulatum* n.sp., holotype, 3.4 mm, E of Malabar, Sydney, New South Wales, Australia. Scales represent 0.1 mm.

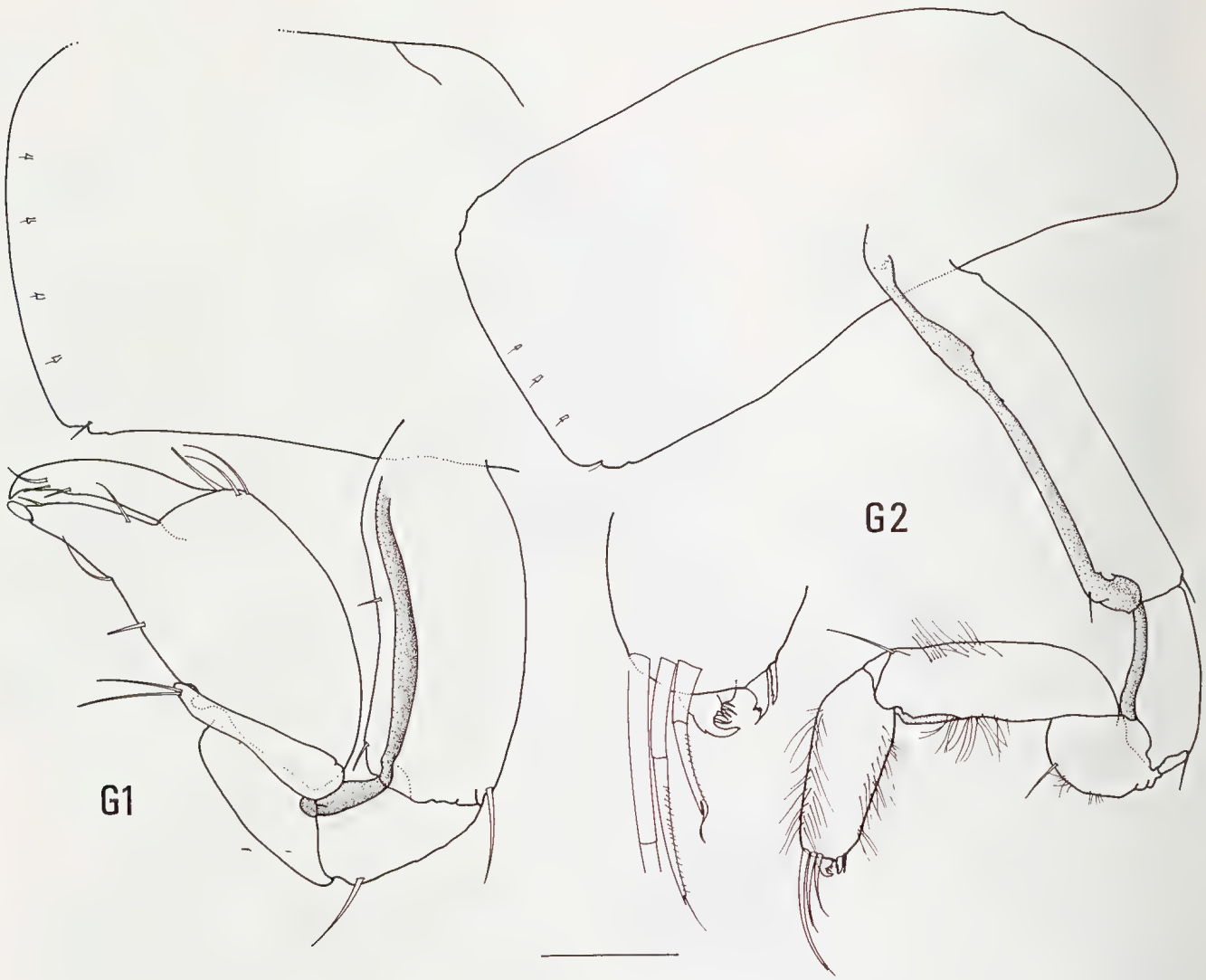

Fig. 26 *Pachynus denticulatum* n.sp., holotype, 3.4 mm, E of Malabar, Sydney, New South Wales, Australia. Scale represents 0.1 mm.

Material examined. HOLOTYPE, 1 slide, AHF 5510, slide L.7, 1.7 miles W of end of pier, Manhattan Beach, Los Angeles County, California, 33°52′43″N 118°26′53″W, 40 m, Hayward grab, black mud, 5 February 1955, Station 2991-55. Additional AHF material: 1 specimen, Monterey Bay, California, 82 m, Station 6458; 1 specimen, Mugu Canyon, California, 171 m, Station 4851; 1 specimen, Newport Canyon, California, 97 m, Station 5367.

Diagnosis. Antenna 1, accessory flagellum 2-articulate. Maxilla 1, outer plate with a 5/3 spine-tooth formula; palp with 2 terminal articulating spines. Gnathopod 1 chelate; article 6 moderately produced posterodistally. Peraeopod 7, article 2 slightly longer than broad, posterior margin and posteroventral corner gently rounded. Uropods not covered in minute denticles. Uropod 3, inner ramus subequal in length to article 1 of outer ramus.

Remarks. *Pachynus barnardi* is closely related to *P. chelatum*, as discussed under that species.

Distribution. *Pachynus barnardi* is known from several sites off the coast of southern California and Mexico in depths between 12 and 800 m.

Pachynus denticulatum n.sp.

Figs 25-27

Type-material. HOLOTYPE, 3.4 mm, AM P24232, E of Malabar, Sydney, Australia, 151°19′E 33°57′S, Shipek grab, medium sand, 69 m, Australian Museum Shelf Benthic Survey, 17 May 1972.

Additional material examined. One specimen, AM P33837, Halifax Bay, Queensland, Australia, 19°07′S, 146°33′E, 2 m, January 1978, Station 78-1-A.

Diagnosis. Antenna 1 with accessory flagellum absent. Maxilla 1, outer plate with a 5/3 spine-tooth formula, tooth 1 on inner row enlarged; palp with 2 terminal articulating spines. Gnathopod 1 chelate, article 6 strongly produced posterodistally. Peraeopod

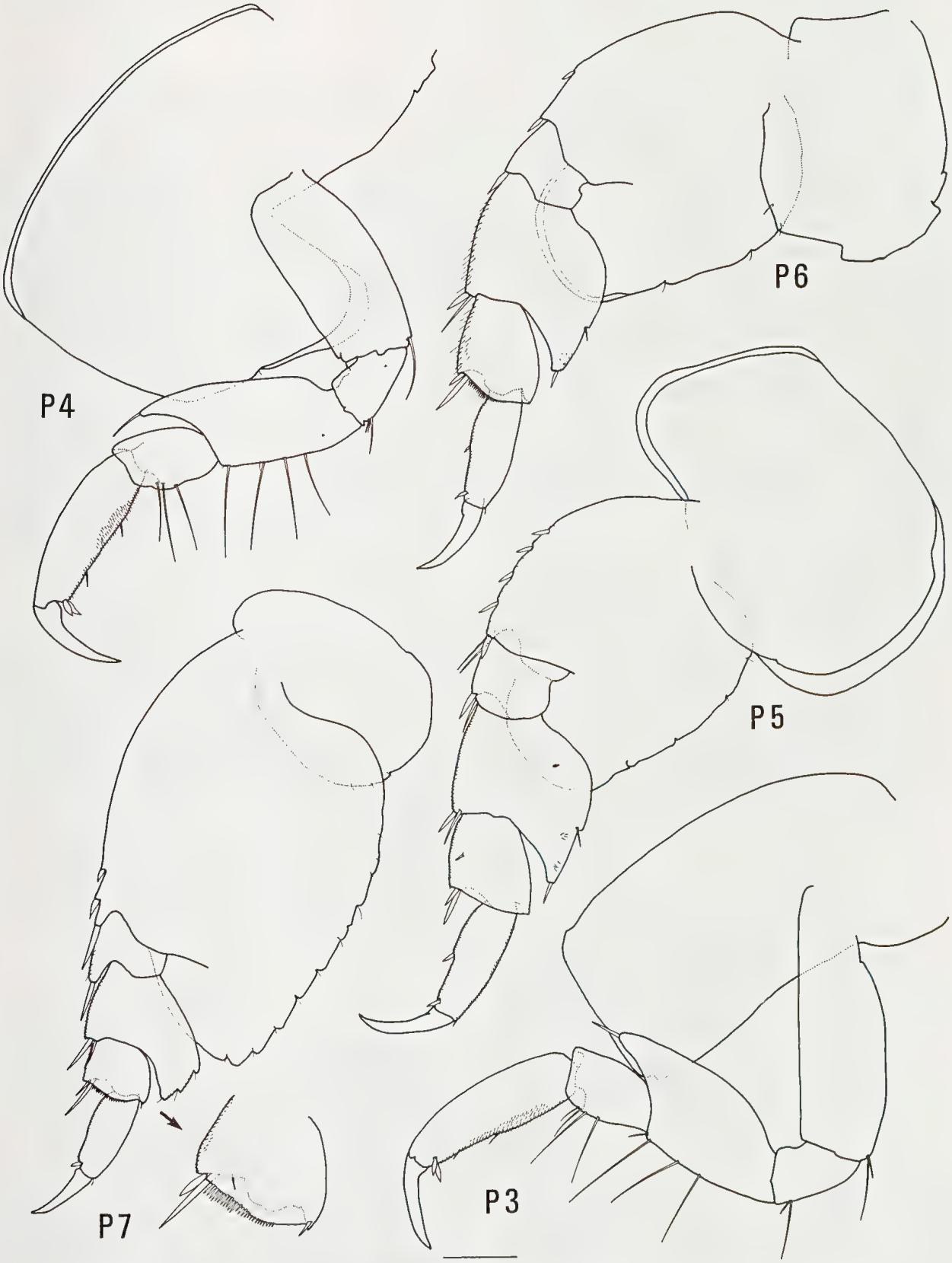

Fig. 27 *Pachynus denticulatum* n.sp., holotype, 3.4 mm, E of Malabar, Sydney, New South Wales, Australia. Scale represents 0.1 mm.

7, article 2 longer than broad, posterior margin straight, posteroventral corner subacute. Uropods covered in minute denticles. Uropod 3, inner ramus subequal in length to article 1 of outer ramus.

Description. Holotype, 3.4 mm. *Antenna 1:* peduncle large, more than twice as long as flagellum; flagellum damaged, at least 3-articulate, proximal articles fused, bearing rows of aesthetascs; accessory flagellum absent. *Antenna 2* slender, shorter than antenna 1; flagellum 5-articulate.

Mandible: left side not known, right side with 3 accessory spines; palp slender, article 2 longer than article 3, with 3 mediodistal setae; article 3 with 5 terminal setae. *Maxilla 1:* inner plate small, subquadrate, without setae; outer plate with 8 spine-teeth in a 5/3 formula, tooth 1 on inner row enlarged; palp with 2 terminal spines. *Maxilla 2:* short with subquadrate plates, each bearing 4 stout terminal setae. *Maxilliped* unknown.

Gnathopod 1 large, chelate; coxa subquadrate; article 6 longer than broad, strongly produced posterodistally, palm defined by a concave spine. *Gnathopod 2* minutely chelate, article 5 longer than article 6; article 6 more than twice as long as broad.

Peraeopod 4: coxa with projecting posteroproximal corner on posteroventral lobe; article 4 shorter than article 6 with anterior margin produced halfway along article 5; article 6 with minute denticles along posterior margin. *Peraeopod 5:* article 2 longer than broad, posterior margin straight, anterior margin with 5 short spines; article 4 large, posteroproximal corner broadly rounded. *Peraeopod 6:* article 2 longer than broad, posterior margin straight, anterior margin with 2 short spines; article 4 large, posteroproximal corner broadly rounded. *Peraeopod 7:* article 2 longer than broad, posterior margin straight, crenulate, posteroventral corner sharply rounded; article 4, posterior margin oblique, slightly convex with 3 minute posterodistal setae.

Uropod 1: peduncle subequal in length to outer ramus; inner ramus slightly shorter than outer ramus; both covered in minute denticles. *Uropod 2:* peduncle as long as rami; rami subequal in length, stockier than rami of uropod 1 and covered in minute denticles. *Uropod 3:* peduncle about as long as outer ramus; inner ramus as long as article 1 of outer ramus; rami covered in minute denticles. *Telson* slightly longer than broad, entire, with 2 pairs of short terminal sete.

Etymology. The name *denticulatum* refers to the minute denticles on the uropods.

Remarks. *Pachynus denticulatum* appears to be the most apomorphic species in the genus. It differs significantly from other *Pachynus* species in the morphology of the spine-teeth on maxilla 1, the enlarged article 2 of peraeopod 7 and the presence of minute denticles on the uropods.

Distribution. *Pachynus denticulatum* is known along the coast of eastern Australia from one specimen collected off Port Jackson, New South Wales in 69 m depth and one specimen collected in Halifax Bay, Queensland in 2 m depth.

Figorella J.L. Barnard, 1962

Figorella J.L. Barnard, 1962: 24.—1969a: 343.

Diagnosis. Antenna 1, proximal articles of flagellum not fused in male or female, male reproductive stage not known. Left mandible with lacinia mobilis, small accessory spines on both mandibles. Maxilla 1, inner plate subquadrate with several terminal setae; outer plate with 10 smooth spine-teeth; palp 2-articulate with small terminal setae. Maxilla 2 with short subquadrate plates bearing terminal and subterminal setae. Maxilliped, inner plates small with several apical setae; outer plates large, reaching to the end of palp article 3; palp 4-articulate. Gnathopod 1 subchelate, palm defined by simple spine. Gnathopod 2, dactyl large, palm slightly oblique. Coxa 4 with well-developed posteroventral lobe. Peraeopods 5 and 6, article 4 expanded posteriorly with weakly-developed posteroproximal shoulder. Peraeopods 5 to 7, article 5 without minute denticles along distal margin. Uropod 3 biramous.

Type-species. *Figorella tanidea* J.L. Barnard, 1962 (original designation).

Remarks. *Figorella* differs from *Pachynus* in the number of spine-teeth on maxilla 1, in not having fused proximal articles on the flagellum of antenna 1 in adult males and female, and in having terminal setae on the palp of maxilla 1. *Figorella* shows some relationship to *Acheronia* in that neither genus has fused proximal articles on the flagellum of antenna 1 and both have terminal setae on the palp of maxilla 1. Both *Ekelofia* and *Figorella* have a simple spine defining the palm of gnathopod 1.

Figorella contains two species, *F. tanidea* known from the East Scotia Basin off South Georgia and *F. tasmanica* known from the Tasman Sea off south-eastern Australia.

Figorella tasmanica n.sp.

Figs 28-30

Type-material. HOLOTYPE, female, 3.7 mm, AM P31998; 22 PARATYPES, 2.6 to 5.9 mm, AM P 25477; E of Port Kembla, New South Wales, Australia, 34°27'S 151°27'E, from Globigerina ooze, 1200 m, J.K. Lowry on FRV *Kapala*, 13 December 1976, K76-23-02.

Additional material examined. One specimen, AM P33632, off Sydney, New South Wales, Australia, 33°37'S, 152°04'E to 33°39'S 152°02'E, dredged, 914 m, R. Springthorpe and P. Colman on FRV *Kapala*, 10 December 1980, K80-20-08. One specimen, AM P33633, NE of Port Jackson, New South Wales, Australia, 33°41'S 152°01'E, epibenthic sled, 615 m, Australian Museum party on FRV *Kapala*, 11 December 1978, K78-27-03.

Diagnosis. Mandible with 4 accessory spines. Maxilla 1, outer plate with a 5/5 spine-tooth formula.

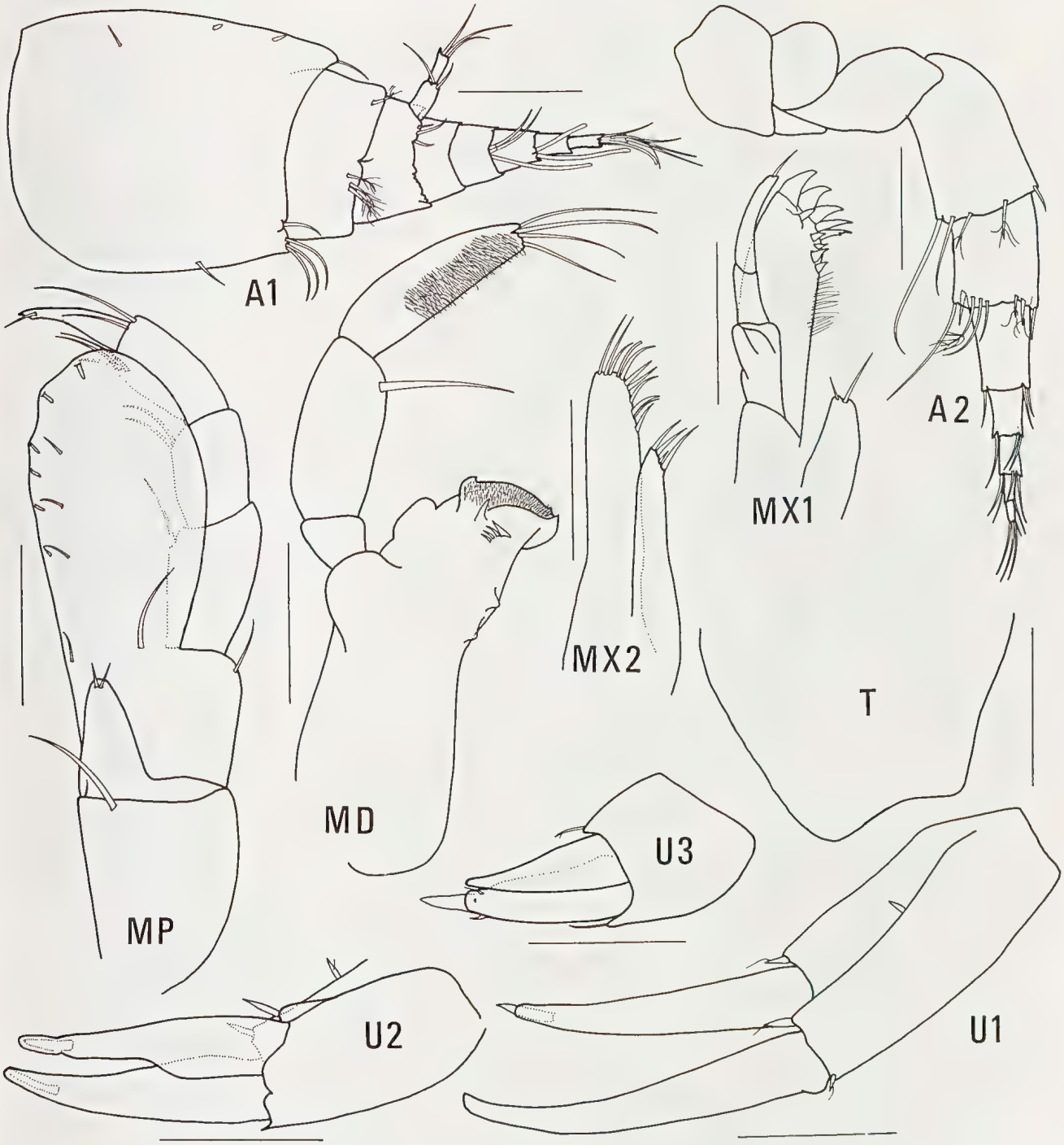

Fig. 28 *Figorella tasmanica* n.sp., holotype, female, 3.7 mm, E of Port Kembla, New South Wales, Australia. Scales represent 0.1 mm.

Gnathopod 2 with slightly oblique palm. Peraeopods 5 and 6 with article 4 strongly expanded posteriorly. Peraeopod 7, article 2 with slightly emarginate posteroventral corner. Uropod 3, inner ramus subequal in length to outer ramus.

Description. Holotype female, 3.7 mm. *Antenna 1:* peduncular article 1 more than twice as long as articles 2 and 3 combined, peduncle twice as long as 6-articulate flagellum; accessory flagellum 2-articulate. *Antenna 2* subequal to antenna 1; flagellum 5-articulate.

Mandible: left lacinia mobilis present; 4 accessory spines present; 3-articulate palp attached midway along dorsal edge, article 2 broad, shorter than article 3 with one large distal seta, article 3 covered in minute hairs,

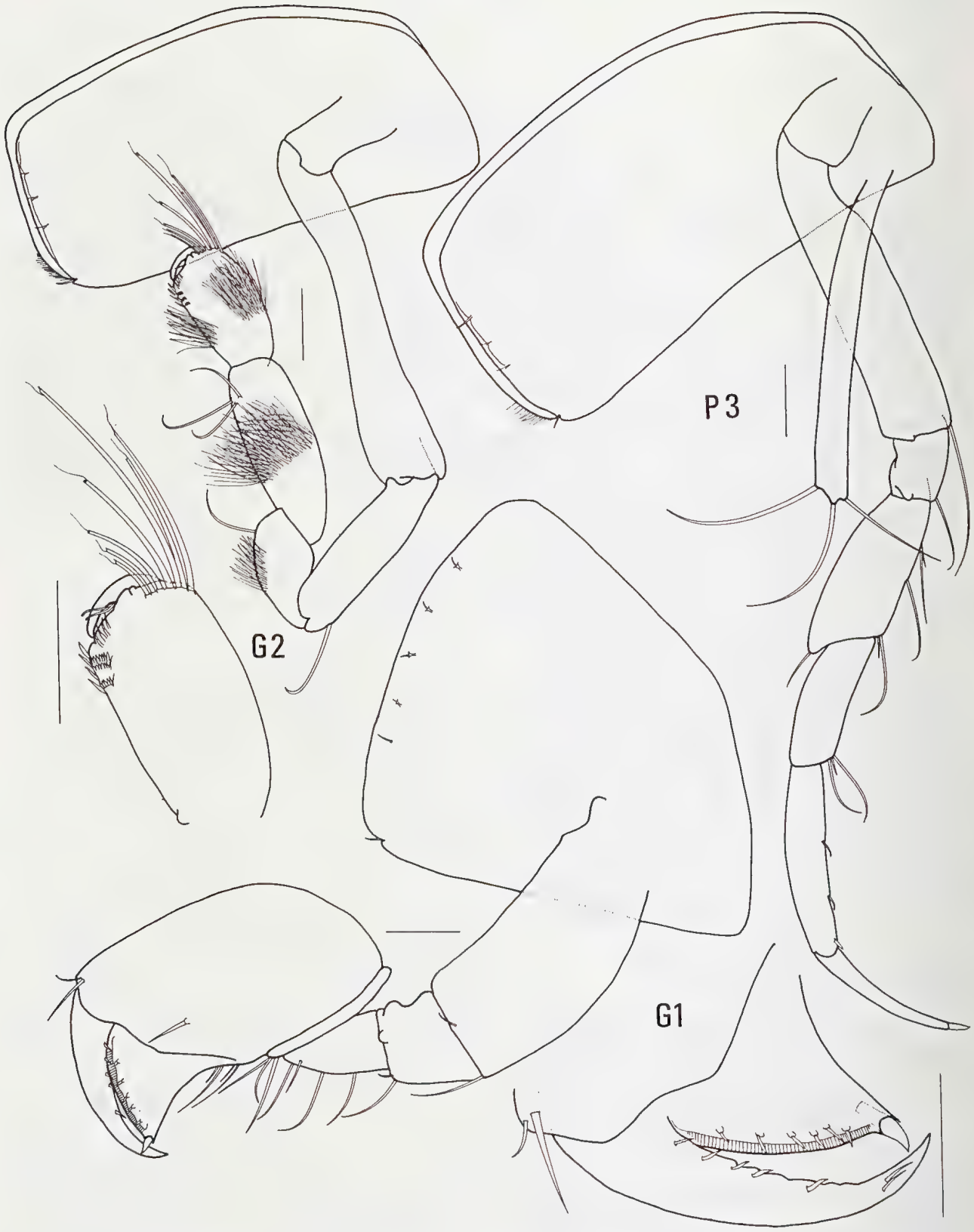

Fig. 29 *Figorella tasmanica* n.sp., holotype, female, 3.7 mm, E of Port Kembla, New South Wales, Australia. Scales represent 0.1 mm.

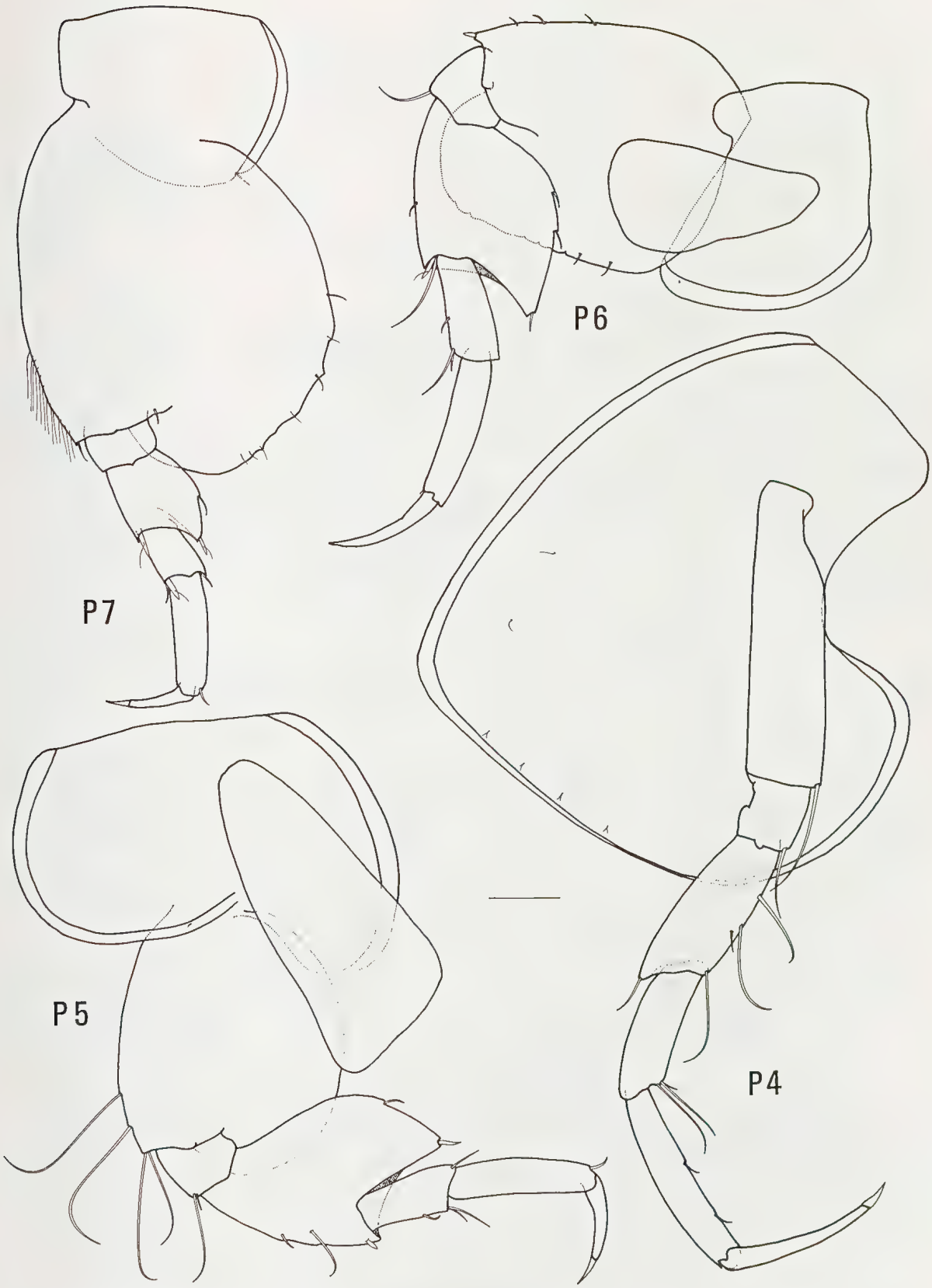

Fig. 30 *Figorella tasmanica* n.sp., holotype, female, 3.7 mm, E of Port Kembla, New South Wales, Australia. Scale represents 0.1 mm.

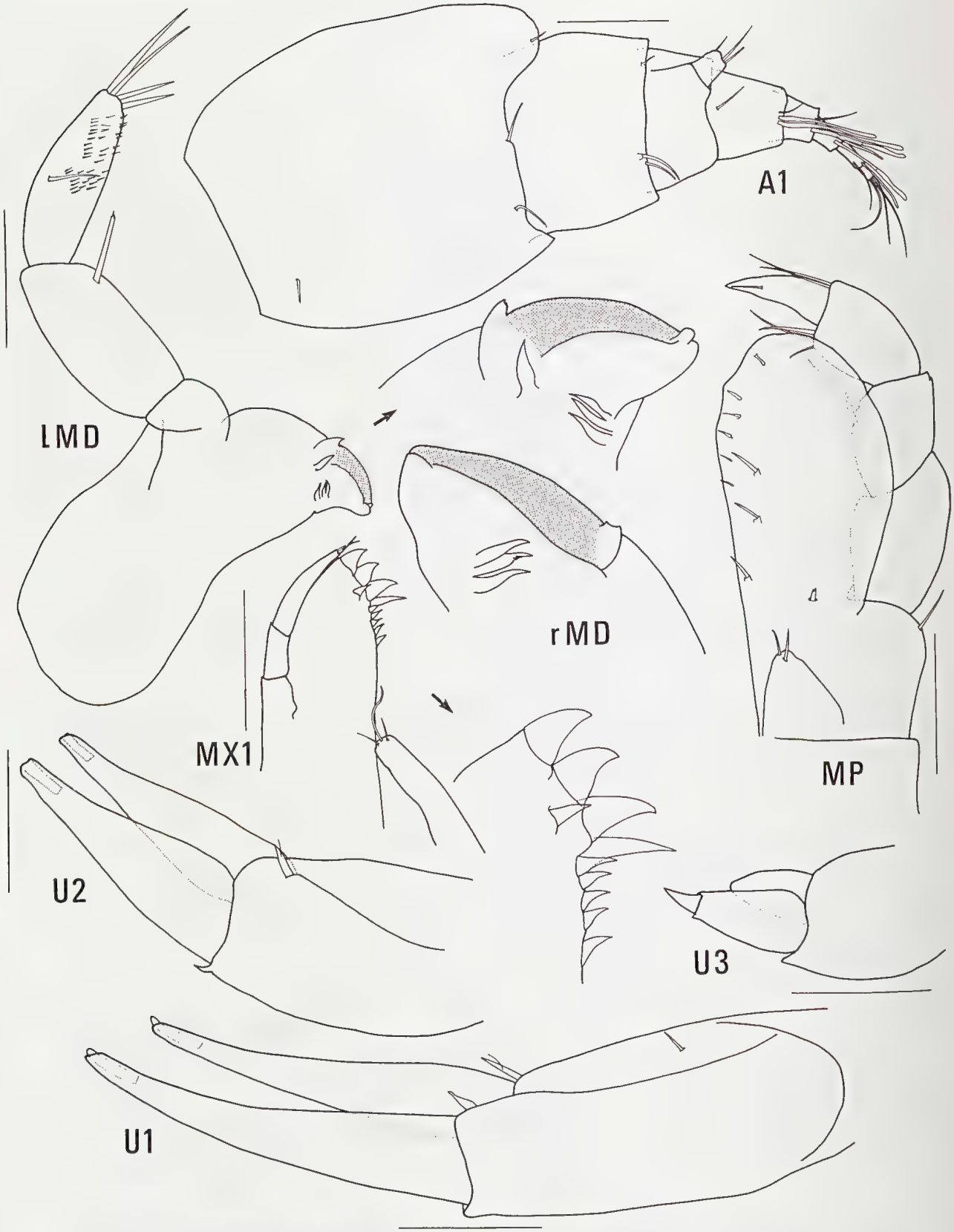

Fig. 31 *Figorella tanidea* J.L. Barnard, holotype, East Scotia Basin, South Atlantic Ocean. Scales represent 0.1 mm.

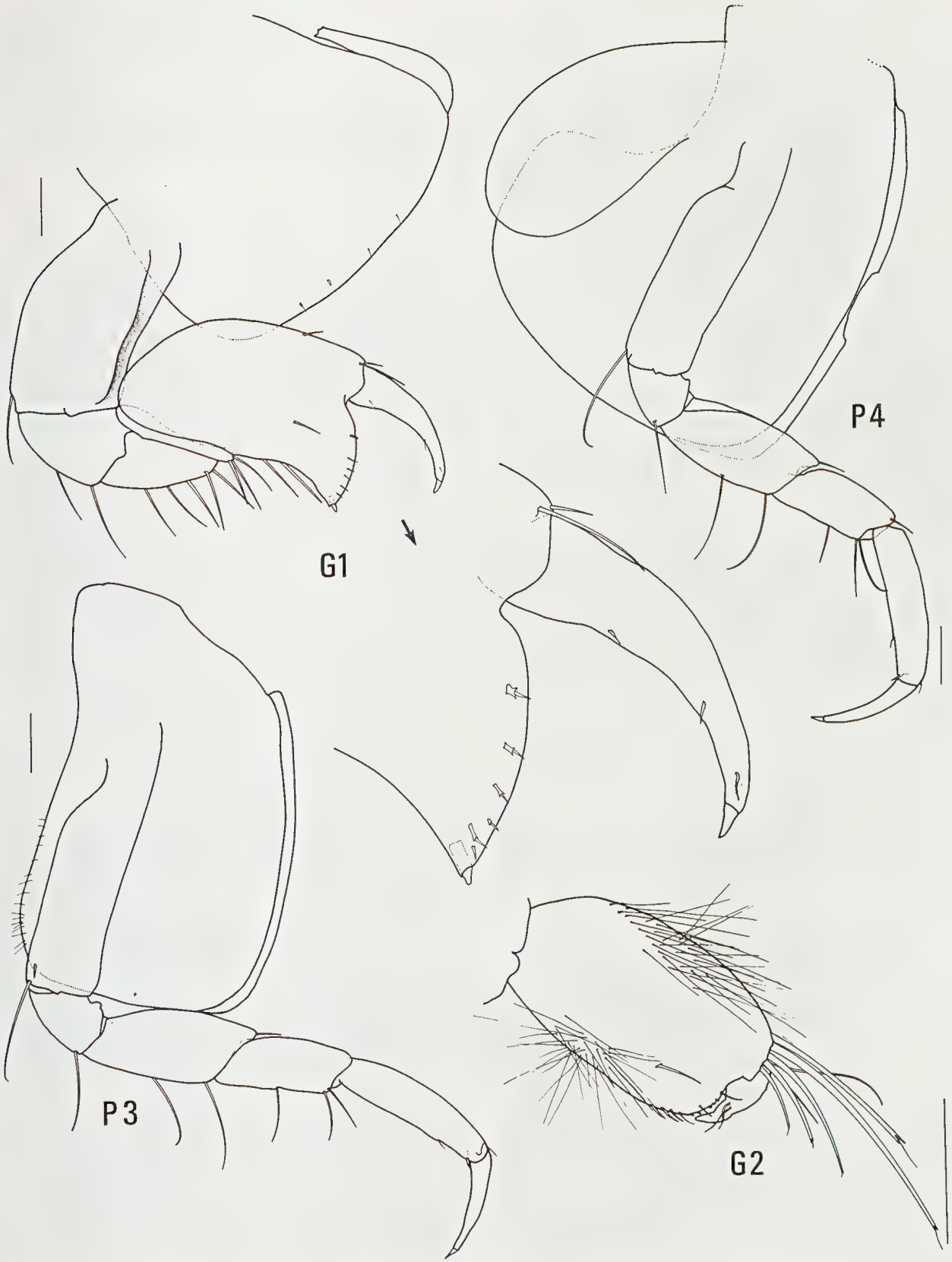

Fig. 32 *Figorella tanidea* J.L. Barnard, holotype, East Scotia Basin, South Atlantic Ocean. Scales represent 0.1 mm.

with 4 large terminal setae. *Maxilla 1:* inner plate reduced, narrow, subquadrate with 2 terminal setae; outer plate with 10 spine-teeth in a 5/5 formula; palp 2-articulate with 1 terminal seta. *Maxilla 2* reduced; inner plate with 4 terminal setae; outer plate with about 11 terminal setae. *Maxilliped:* inner plates present but reduced; outer plates large, subovate, reaching to distal end of palp article 3; palp slender, 4-articulate.

Gnathopod 1 large, subchelate; coxa expanded distally; article 6 large, longer than broad, palm convex, defined by a large simple spine; dactyl closing along entire palmar margin. *Gnathopod 2* subchelate; article 5 longer than article 6; article 6 with slightly oblique palm, about 3 serrate spines posterodistally.

Peraeopod 3: coxa twice as long as broad, subquadrate; dactyl long and thin. *Peraeopod 4:* coxa as long as broad, strongly produced posteroventrally; otherwise similar to peraeopod 3. *Peraeopod 5:* article 2 with an evenly rounded posterior margin; article 4 large, strongly expanded posteriorly. *Peraeopod 6* similar to peraeopod 5; article 2 with posterior margin straight. *Peraeopod 7:* article 2 larger than article 2 of peraeopods 5 and 6, rounded posteriorly; article 4 smaller than article 4 of peraeopods 5 and 6, not expanded posteriorly.

Uropod 1: peduncle slightly shorter than rami; outer ramus longer than inner ramus. *Uropod 2* shorter than uropod 1; peduncle shorter than rami; rami subequal in length. *Uropod 3* shorter than uropod 2; peduncle shorter than rami; inner ramus nearly as long as outer ramus. *Telson* emarginate, as broad as long, tapering distally.

Etymology. The specific name refers to the Tasman Sea.

Remarks. *Figorella tasmanica* is related to *F. tanidea* as outlined under that species.

Distribution. *Figorella tasmanica* is known from several collections made in 615 to 1200 m depth off the east coast of New South Wales, Australia. The species appears to be relatively common in this area.

Figorella tanidea J.L. Barnard, 1962
Figs 31-33

Figorella tanidea J.L. Barnard, 1962: 25, figs 7, 8.—Lowry and Bullock, 1976: 90.

Material examined. HOLOTYPE, AMNH 11905, East Scotia Basin, South Atlantic Ocean, 55°29'S 37°57'W, 3770 m, 6 March 1958, *Vema* Station 47.

Diagnosis. Mandible with 3 accessory spines. Maxilla 1, outer plate with a 4/6 spine-tooth formula. Gnathopod 2 with almost transverse palm. Peraeopods 5 and 6 with article 4 moderately expanded posteriorly. Peraeopod 7, article 2 with rounded posteroventral corner. Uropod 3, inner ramus shorter than article 1 of outer ramus.

Remarks. Although *F. tanidea* and *F. tasmanica* appear to be separated by a great distance they are very closely related. The most important morphological differences occur in the mouthparts, but the most obvious differences are seen in peraeopod 7 and uropod 3. Until further collections of these interesting deep-sea pachynids become available for study little more can be said.

Distribution. *Figorella tanidea* is known from one specimen collected off South Georgia in the East Scotia Basin in 3770 m depth.

Acheronia n.gen.

Diagnosis. Antenna 1, proximal articles of flagellum not fused in adult female, male reproductive stage not known. Mandible with lacinia mobilis absent, small accessory spines present. Maxilla 1, inner plate subquadrate with 2 terminal setae; outer plate with 6 smooth spine-teeth in a 3/3 formula; palp 2-articulate with several apical setae. Maxilla 2 with short plates, inner plate tapering distally with apical setae; outer plate subquadrate with medial and terminal setae. Maxilliped, inner plates small; outer plates large, reaching end of palp article 3; palp 4-articulate. Gnathopod 1 subchelate, palm defined by projecting tooth. Gnathopod 2, dactyl large, palm extremely oblique. Coxa 4 with well-developed posteroventral lobe. Peraeopods 5 and 6, article 4 expanded posteriorly, with well-developed posteroproximal shoulder. Peraeopods 5 to 7, article 5 without minute denticles along distal margin. Uropod 3 biramous.

Type-species. *Acheronia pegasus* n.sp.

Etymology. The generic name refers to the *Acheron*, the support ship which carried supplies and personnel for expeditions to the New Zealand subantarctic islands during the 1970's.

Remarks. *Acheronia* is a remarkable genus known from one species, *A. pegasus*, living on the Campbell Plateau south of New Zealand. The only derived characters which separate *Acheronia* from other pachynids are the large dactyl and extremely oblique palm of gnathopod 2. The structure of the palm and dactyl is most similar to the large dactyl and slightly oblique palm of gnathopod 2 in *Figorella*. *Acheronia* and *Figorella* also share terminal setae on the palp of maxilla 1, but *Acheronia* has lost the lacinia mobilis on the mandible, has a greatly reduced spine-tooth formula on maxilla 1 and does not have a simple spine defining the palm of gnathopod 1.

Acheronia has the same spine-tooth formula as *Pachychelium* and both genera have a tooth defining the palm of gnathopod 1. *Acheronia* differs from *Pachychelium* in having accessory spines on the mandible, a 2-articulate palp on maxilla 1, a well-developed posteroventral lobe on coxa 4 and well-developed posteroproximal shoulders on the expanded fourth article of peraeopods 5 and 6.

Acheronia may show some relationship to *Ekelofia* in the number of accessory spines and the loss of the lacinia mobilis on the mandible.

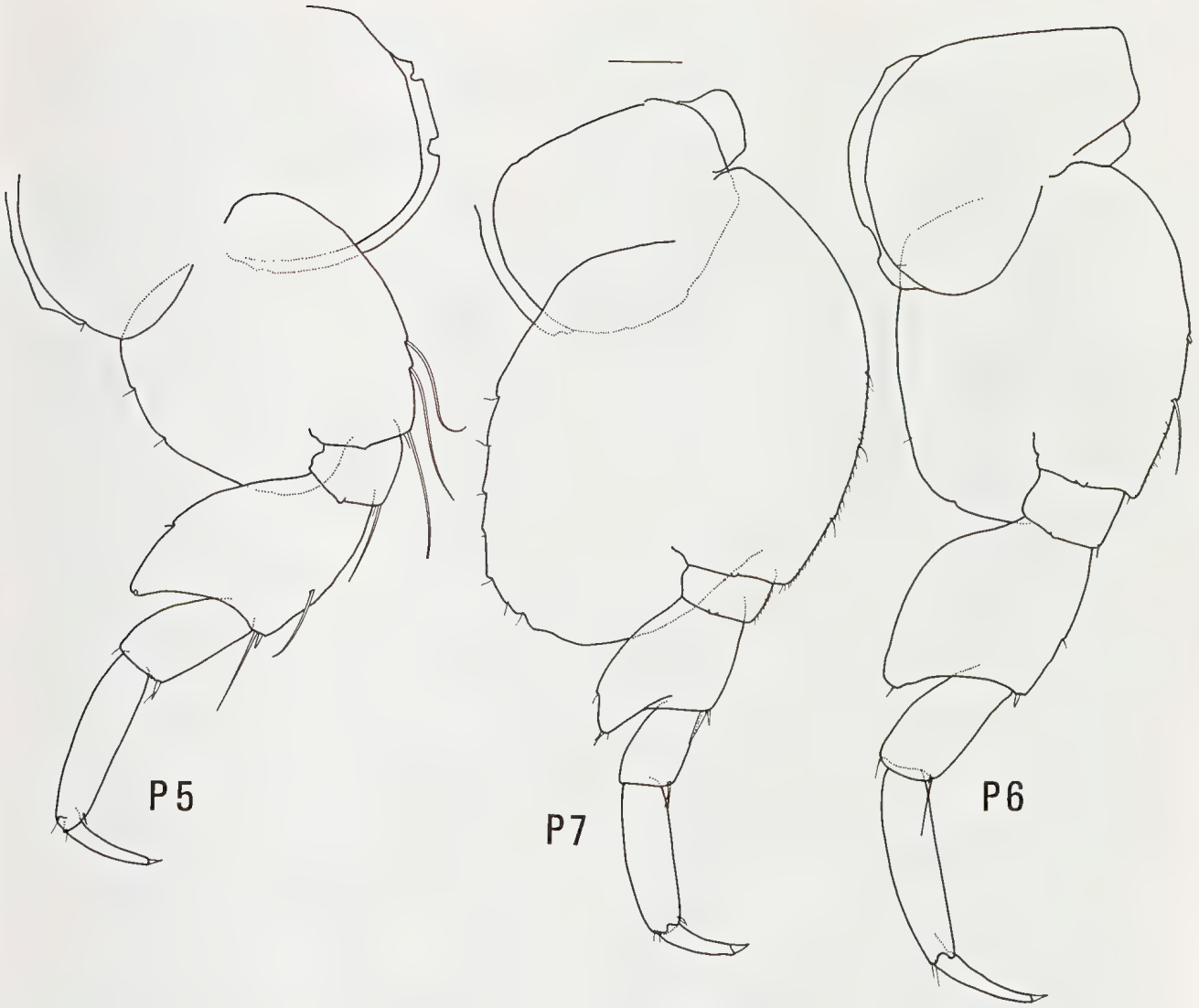

Fig. 33 *Figorella tanidea* J.L. Barnard, holotype, East Scotia Basin, South Atlantic Ocean. Scale represents 0.1 mm.

Acheronia pegasus n.sp.
Figs 34-36

Type-material. HOLOTYPE, 4.3 mm, NMNZ CR2534; 1 PARATYPE, NMNZ CR2535; 1 PARATYPE, AM P31999; North Arm, Port Pegasus, Stewart Island, New Zealand, 47°10′S 167°41′E, sandy-silt bottom, 42 m, J.K. Lowry on the *Acheron*, 23 March 1972.

Diagnosis. As for genus.

Description. Holotype, 4.3 mm. *Antenna 1* short, stocky; peduncle twice as long as 6-articulate flagellum; accessory flagellum 2-articulate. *Antenna 2* subequal to antenna 1; flagellunm 5-articulate.

Mandible: lacinia mobilis absent; 2 accessory spines present; palp attached midway along dorsal margin, article 2 slightly longer than article 3 with at least 2 long distal setae, article 3 sparsely covered with minute hairs and bearing 3 subterminal and 3 terminal setae. *Maxilla 1:* inner plate reduced, narrow, subquadrate with 2 terminal setae; outer plate with 6 spine-teeth in a 3/3 formula; palp lost from holotype, 2-articulate in paratype. *Maxilla 2:* inner plate reduced with 3 terminal setae; outer plate reduced with 2 terminal and 4 subterminal setae. *Maxilliped:* inner plate vestigial, outer plate large, subovate, reaching midway along palp article 3 with small spines along medial margin; palp slender, 4-articulate.

Gnathopod 1 large, subchelate; coxa about as broad as long with produced and rounded anteroventral corner; article 6 large, longer than broad, palm transverse, posterior corner with large tooth; dactyl closing along entire palmar margin. *Gnathopod 2* subchelate; coxa longer than broad; article 5 slightly longer than article 6; article 6 with serrate spines on posterior margin, palm extremely oblique; dactyl large.

Peraeopods 3 and 4: coxa 3 similar to coxa 2; coxa 4 as long as coxa 3 but strongly produced posteroventrally; in other respects very similar.

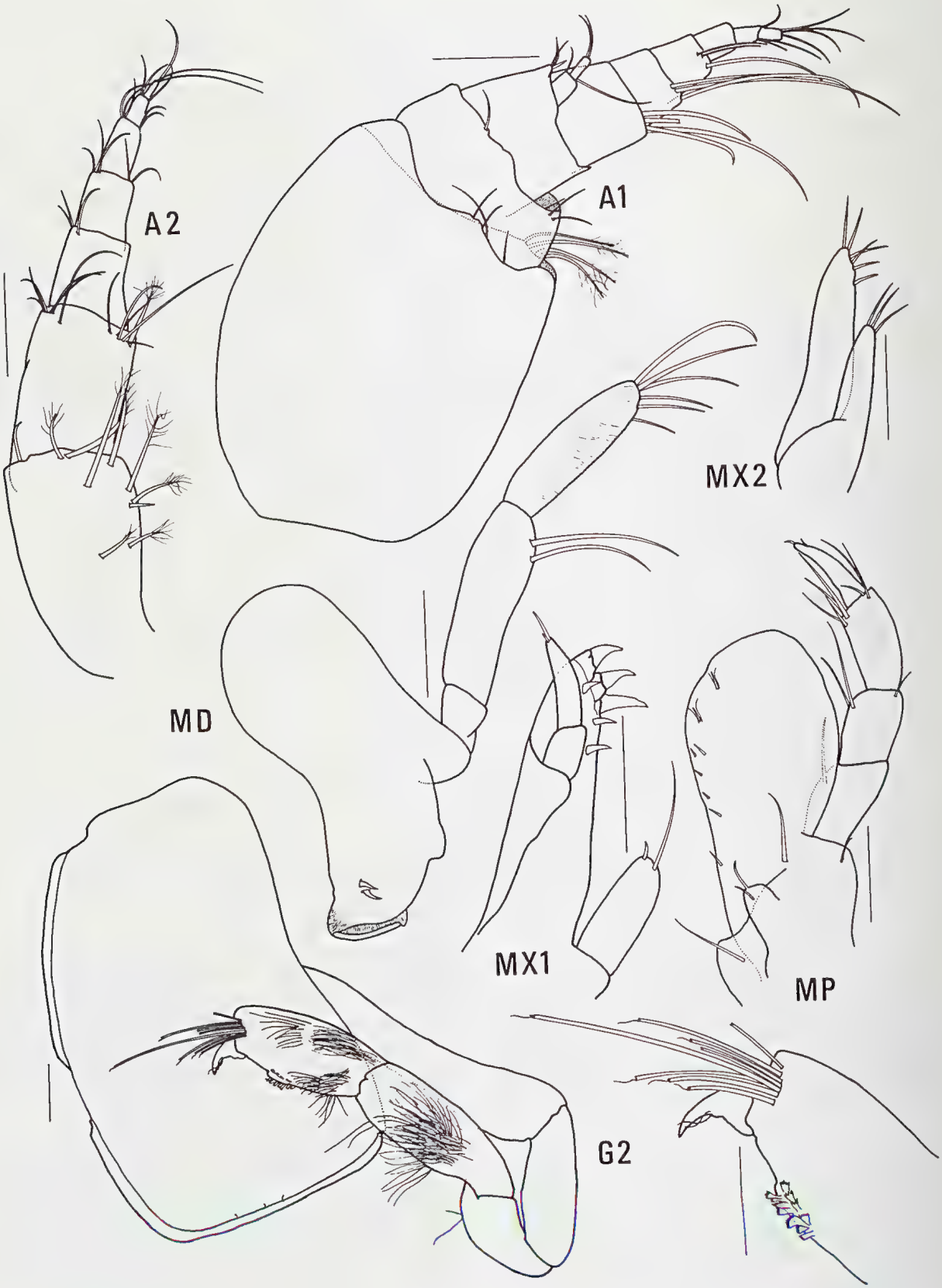

Fig. 34 *Acheronia pegasus* n.gen. n.sp., holotype, 4.3 mm; MXI, paratype; North Arm, Port Pegasus, Stewart Island, New Zealand. Scales represent 0.1 mm.

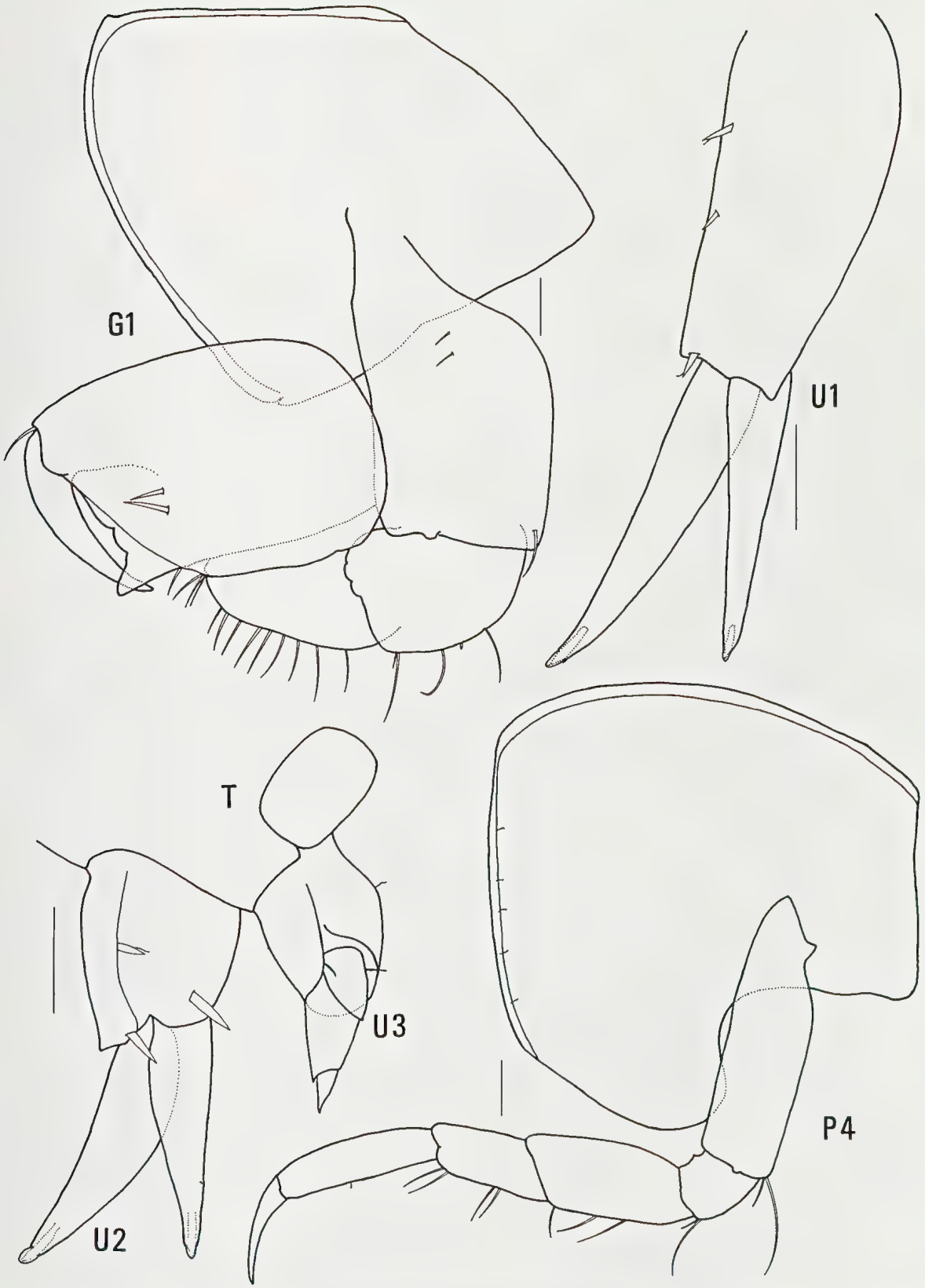

Fig. 35 *Acheronia pegasus* n.gen. n.sp., holotype, 4.3 mm; North Arm, Port Pegasus, Stewart Island, New Zealand. Scales represent 0.1 mm.

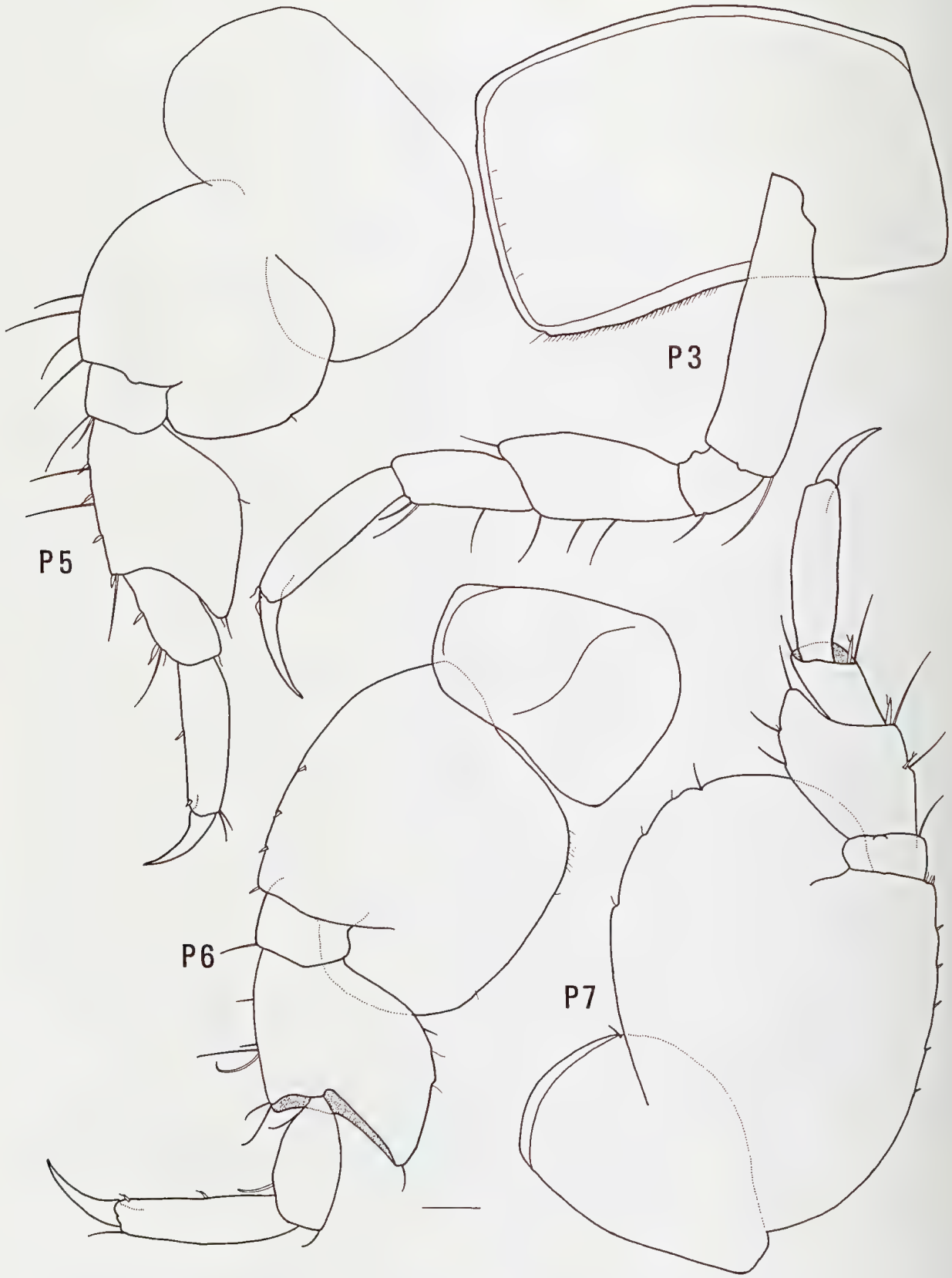

Fig. 36 *Acheronia pegasus* n.gen. n.sp., holotype, 4.3 mm; North Arm, Port Pegasus, Stewart Island, New Zealand. Scales represent 0.1 mm.

Peraeopod 5: article 2 slightly broader than long, ovate, article 4 expanded posteriorly, posterior margin straight and extending halfway along posterior margin of article 5. *Peraeopod 6:* article 2 slightly longer than broad; article 4 strongly expanded posteriorly, posterior margin slightly rounded. *Peraeopod 7:* article 2 about 1.5 times as long as broad with a rounded, slightly crenulate posterior margin; article 4 narrow with an evenly rounded posterior margin extending midway along article 5.

Uropod 1: peduncle slightly longer than rami; outer ramus slightly longer than inner ramus. *Uropod 2:* peduncle shorter than rami, with 3 stout spines; outer ramus slightly longer than inner ramus, both without marginal spines or setae. *Uropod 3:* peduncle subequal in length to outer ramus; inner ramus reduced, ¼ length of outer ramus. *Telson* broader than long, subrectangular, entire.

Etymology. The specific name refers to Port Pegasus, the type-locality.

Distribution. *Acheronia pegasus* is known from three specimens collected in Port Pegasus, Stewart Island, New Zealand in 42 m depth.

Ekelofia n.gen.

Diagnosis. Antenna 1, flagellum with fused proximal articles bearing aesthetascs. Mandible with lacinia mobilis absent, small accessory spines present. Maxilla 1, inner plate not known; outer plate with 6 smooth spine-teeth in a 4/2 formula; palp absent. Maxilla 2 with short plates; inner plate tapering distally with an apical seta; outer plate subquadrate with medial and terminal setae. Maxilliped lacking inner plates; outer plates large, reaching to end of palp article 4. Gnathopod 1 chelate, palm defined by a simple spine. Gnathopod 2, dactyl and palm minute. Coxa 4 with well-developed posteroventral lobe. Peraeopods 5 and 6, article 4 expanded posteriorly, with posteroproximal shoulder. Peraeopods 5 to 7, article 5 without minute denticles along distal margin. Uropod 3 biramous.

Type-species. *Pachychelium oculatum* Schellenberg, 1931.

Etymology. The genus is named in honour of Dr Eric Ekelöf, leader of the Swedish South Polar Expedition, 1902-03.

Remarks. *Ekelofia* differs from other pachynids in having a 4/2 spine-tooth formula. The spine defining the palm of gnathopod 1 is very similar to that structure in *Figorella,* but *Ekelofia* differs from *Figorella* in many other ways. *Ekelofia* appears to be most closely related to *Pachychelium* through the loss of the lacinia mobilis from the left mandible, the palp on maxilla 1, and the inner plates on the maxilliped, but *Ekelofia* has accessory spines on the mandibles, an articulating spine on the palm of gnathopod 1, a well-developed posteroventral lobe on coxa 4 and an expanded fourth article on peraepods 5 and 6.

Ekelofia contains only one species, *E. oculata*, reported from South Georgia in the Southern Ocean.

Ekelofia oculata (Schellenberg, 1931) n. comb.

Figs 37, 38

Pachychelium oculatum Schellenberg, 1931: 20, fig. 9.—Lowry and Bullock, 1976: 102.

Material examined. HOLOTYPE, 3.9 mm, SMNH type number 722, Svenska Sydpolarexp. 1901-03. N:o 25.21/5 1902. 24-52 m. Grauer Thon, euinige Algen. 54°22'S 36°27'W. Süd-Georgien. Ausserhalb der Kochtopfbucht [now officially King Edward Cove].

Diagnosis. As for genus.

Description. Holotype, 3.9 mm. Eyes present. *Antenna 1:* peduncular article 1 longer than rest of antenna, produced dorsally halfway along article 2 and ventrally completely along article 2; accessory flagellum 2-articulate, shorter than article 1 of flagellum; flagellum at least 3-articulate, article 1 about as broad as long, all articles bearing aesthetascs.

Mandible: lacinia mobilis absent; 2 small accessory spines present; palp 3-articulate, attached just distal to midpoint of dorsal margin, article 2 broad, subequal in length to article 3, with a large mediodistal spine, article 3 with rows of minute hairs and 3 large apical setae. *Maxilla 1:* inner plate missing from specimen; outer plate with 6 spine-teeth in a 4/2 formula; palp absent. *Maxilliped* lacking inner plates; outer plates large, reaching nearly to end of 4-articulate palp.

Gnathopod 1 large, chelate; coxa subquadrate with rounded ventral corners; article 6 large, about 1.75 times as long as broad, palm convex, defined by a large simple spine; posterior margin of article 6 with 4 large long spines; dactyl overreaching palm. *Gnathopod 2* minutely subchelate; article 5 nearly twice as long as article 6; article 6 with about 5 serrate spines along posterodistal margin.

Peraeopod 3: coxa about 1.5 times as long as broad, anterior margin convex; article 4 slightly produced anteriorly and subequal in length to article 6; dactyl short. *Peraeopod 4* similar to peraeopod 3 except coxa produced posteroventrally. *Peraeopod 5:* posterior lobe of article 2 subquadrate; article 4 expanded posteriorly with 2 setae on posterior margin; article 6 subequal in length to article 4, with a mid-distal spine and an apical spine on anterior margin. *Peraeopod 6* similar to peraeopod 5, coxa smaller, remainder of peraeopod larger. *Peraeopod 7:* article 2 larger than article 2 of peraeopods 5 and 6, posterior margin slightly convex with 3 distinct crenulations towards subquadrate posterodistal corner; article 4 with convex posterior margin and 2 posterodistal setae.

Uropod 3 small, peduncle about as long as outer ramus; inner ramus slightly longer than article 1 of outer ramus. *Telson* broader than long, entire, with 4 sensory setae on distal margin.

Distribution. *Ekelofia oculata* is known from one specimen collected near South Georgia in 24-52 m depth.

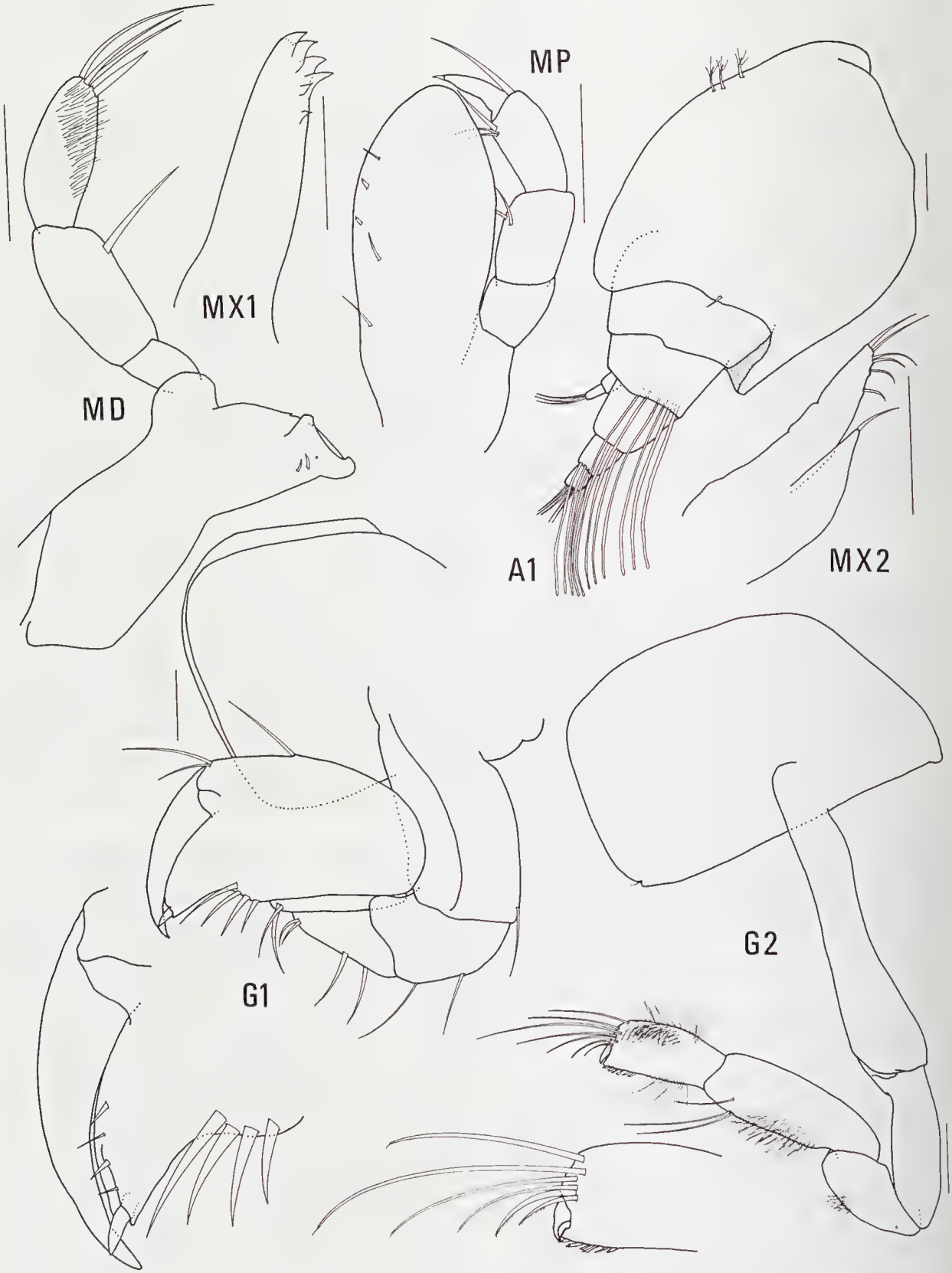

Fig. 37 *Ekelofia oculata* (Schellenberg), holotype, 3.9 mm, South Georgia. Scales represent 0.1 mm.

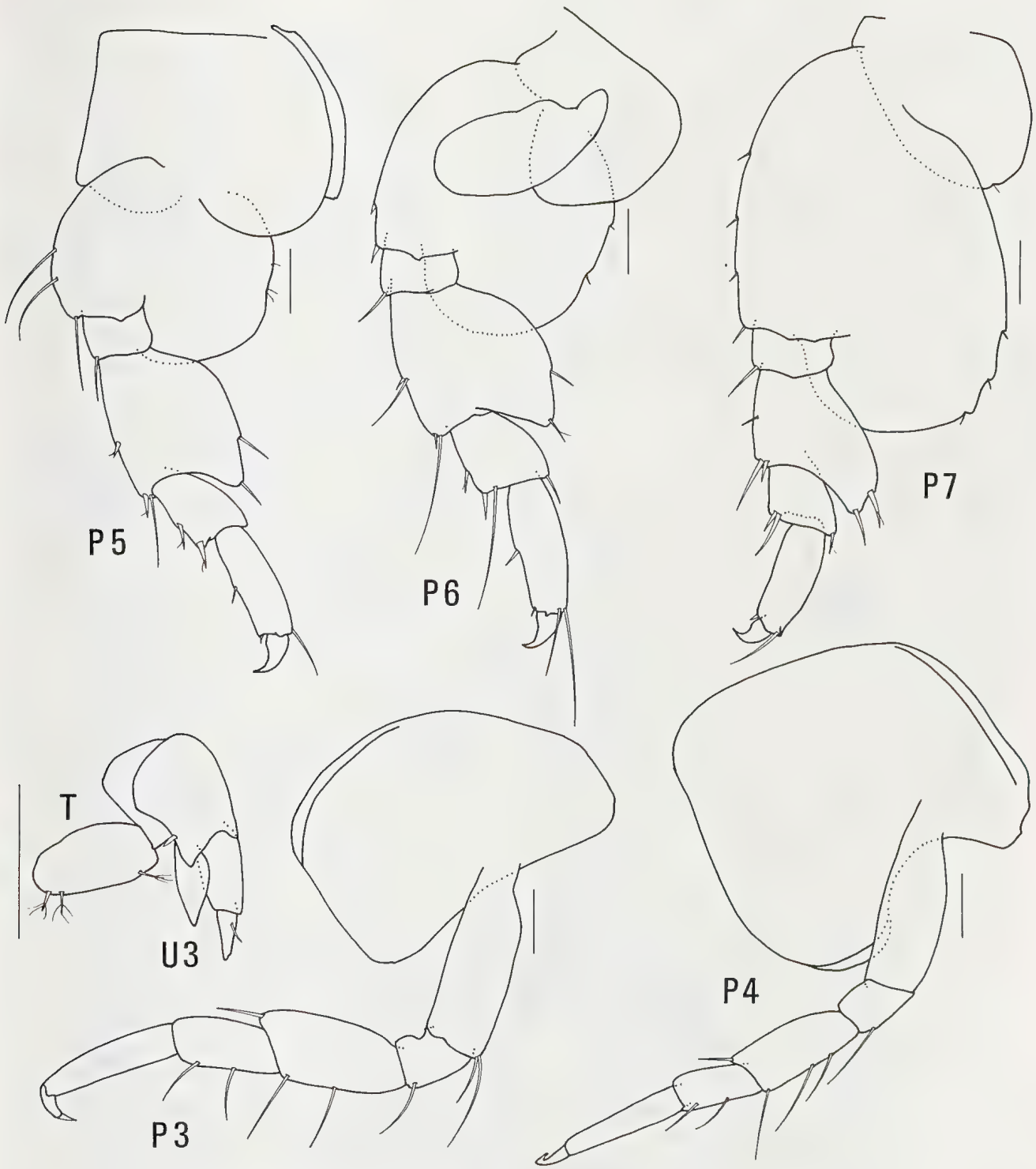

Fig. 38 *Ekelofia oculata* (Schellenberg), holotype, 3.9 mm, South Georgia. Scales represent 0.1 mm.

Pachychelium Stephensen, 1925

Pachychelium Stephensen, 1925: 121.—K.H. Barnard, 1932:75; J.L. Barnard, 1969a: 354.

Diagnosis. Antenna 1, flagellum with proximal articles fused, with or without rows of aesthetascs. Mandible without lacinia mobilis and accessory spines. Maxilla 1, inner plate present, without setae; outer plate with 4-6 smooth spine-teeth; palp absent. Maxilla 2 not known. Maxilliped inner plates small or absent; outer plates large, reaching nearly to end of palp article 3; palp 3- or 4-articulate. Gnathopod 1 subchelate, palm

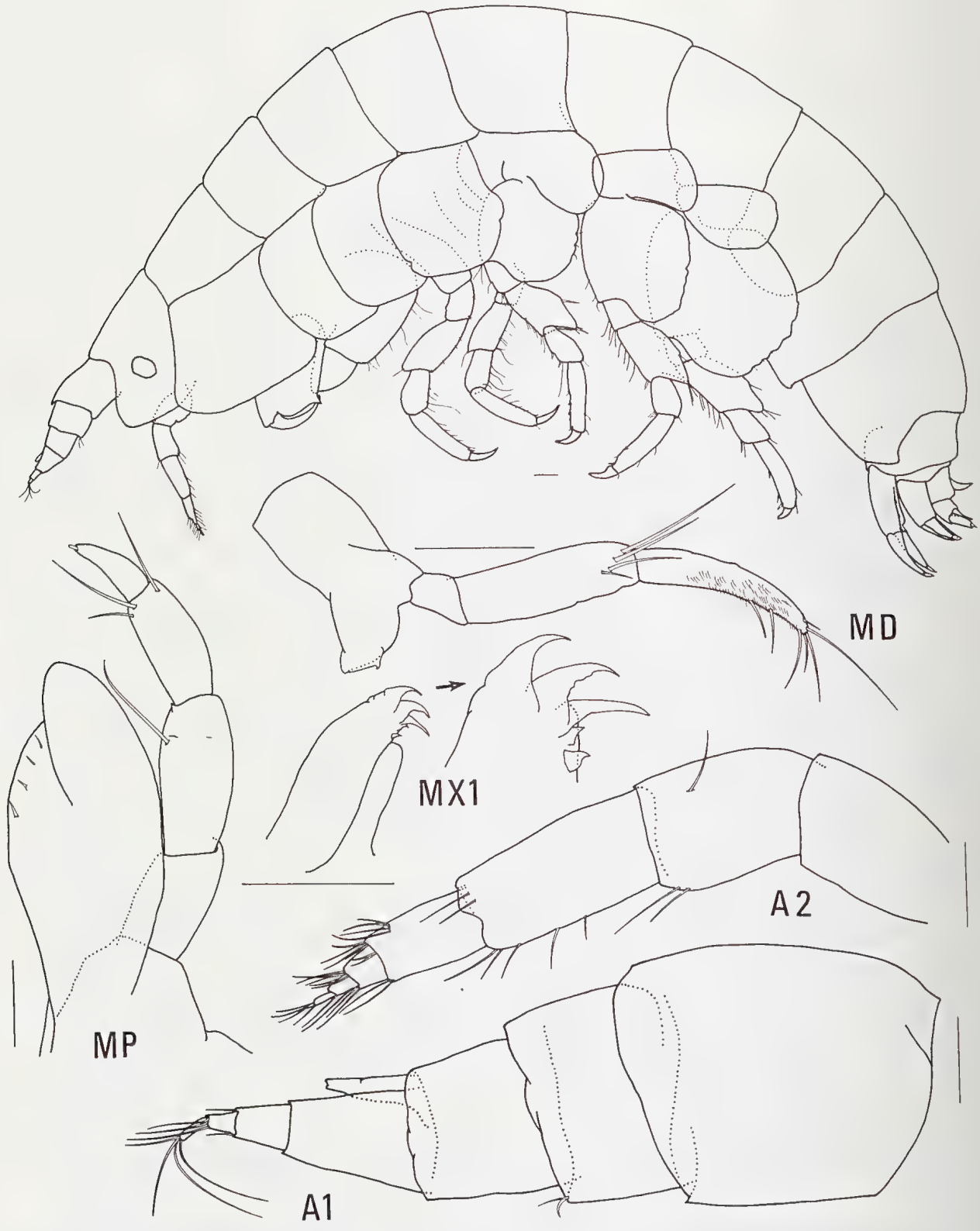

Fig. 39 *Pachychelium schellenbergi* n.sp., holotype, 6.3 mm, Ultima Esperanza, Chile. Scales represent 0.1 mm.

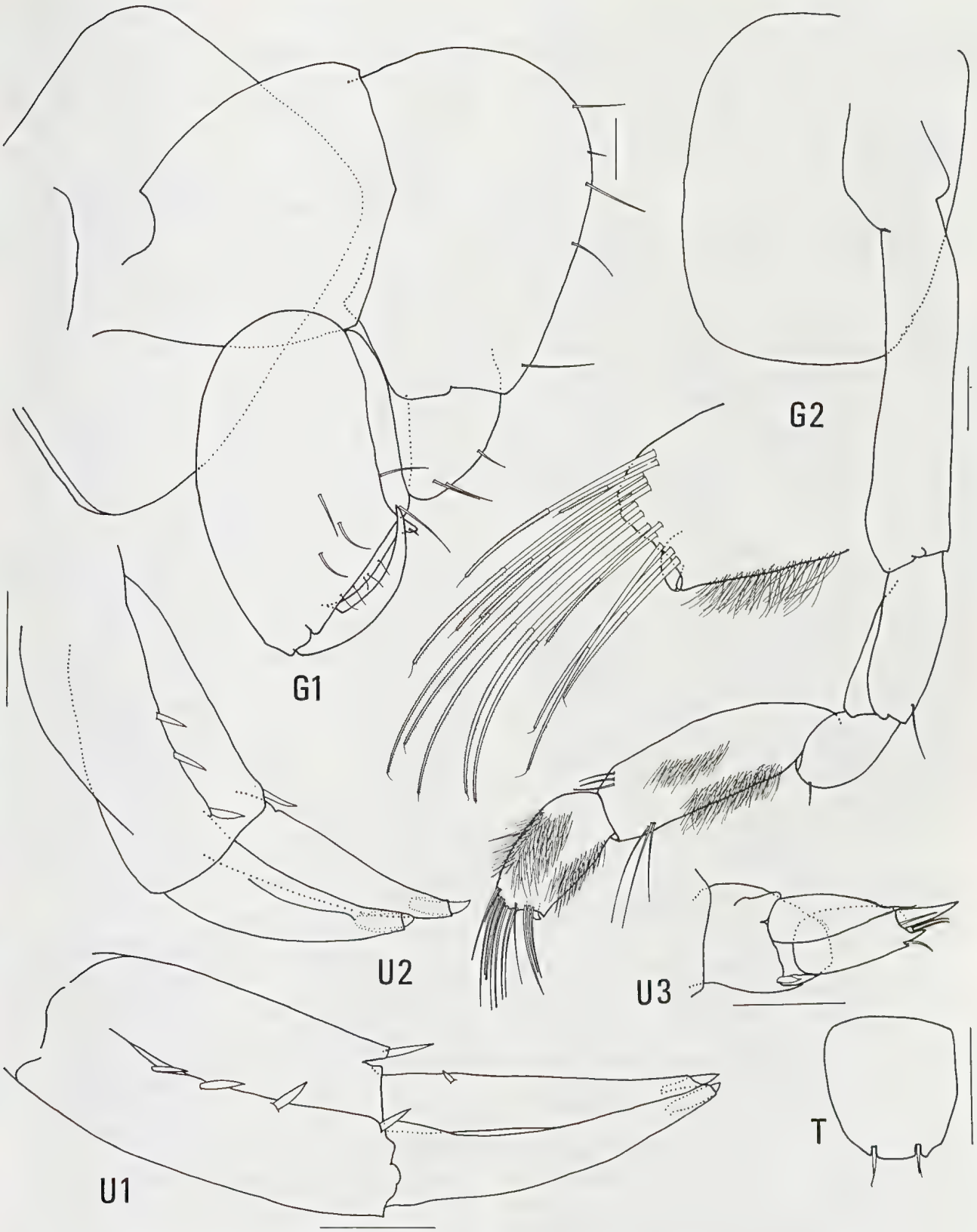

Fig. 40 *Pachychelium schellenbergi* n.sp., holotype, 6.3 mm, Ultima Esperanza, Chile. Scales represent 0.1 mm.

defined by a projecting tooth or not at all. Gnathopod 2, dactyl and palm minute. Coxa 4, posteroventral lobe poorly developed or absent. Peraeopods 5 and 6, article 4 not expanded posteriorly. Peraeopods 5 to 7, article 5 without minute denticles along distal margin. Uropod 3 biramous.

Type-species. *Pachychelium davidis* Stephensen, 1925 (orginal designation).

Remarks. *Pachychelium* is a bipolar genus. Unfortunately the type-species, *P. davidis*, from the Davis Strait, is known from only one specimen. This has made detailed study difficult and some characters are poorly known. More collecting may show that two genera exist. *Pachychelium* exhibits the greatest reduction in morphology of any of the pachynid genera. Species in the genus have lost the lacinia mobilis and the accessory spines on the mandible. They have lost the palp on maxilla 1 and have a greatly reduced number of spine-teeth on the outer plate. They have lost the inner plates on the maxillipeds and some species have lost the fourth article of the maxillipedal palp. The posteroventral lobe of coxa 4 is lost or poorly developed and article 4 of peraeopods 5 and 6 is not expanded posteriorly.

Pachychelium appears to be most closely related to *Ekelofia* with which it shares loss of left lacinia mobilis and accessory spines in the mandibles, loss of maxilla 1 palp and loss of maxillipedal plates. It also appears related to *Acheronia* with which it shares the same spine-tooth formula on maxilla 1 and the projecting tooth defining the palm of gnathopod 1, except for *P. davidis*.

Pachychelium currently contains four species: *P. davidis* from the Davis Strait, *P. schellenbergi* from Tierra del Fuego, and *P. antarctica* and *P. nichollsi* from the Davis Sea in the Southern Ocean.

Pachychelium schellenbergi n.sp.

Figs 39-41

Pachychelium antarcticum.—Schellenberg, 1931: 19, fig. 8.
? *Pachychelium davidis.*—K.H. Barnard, 1932: 75, fig. 32.

Type-material. HOLOTYPE, 6.3 mm, and one PARATYPE (only some parts remaining), ZMB 22721; one PARATYPE, SMNH 2797; Ultima Esperanza, Chile, 51°34′S 72°45′W, algae, mud and stones, 13–15 m, 5 April 1896, Swedish Expedition to Magellan Land, 1895-1897. One PARATYPE, 2.5 mm, SMNH 3808; Berkeley Sound, Falkland Islands, 51°34′S 57°55′W, gravel with mussels and algae, 16 m, 19 August 1902, Swedish Southpolar Expedition, 1901-1903.

Diagnosis. Eyes present. Maxilla 1, outer plate with a 3/2 spine-tooth formula. Maxilliped with 4-articulate palp. Gnathopod 1 subchelate, posterior corner of palm square, defined by a projecting tooth. Gnathopod 2 minutely chelate. Peraeopod 7, posterior margin of article 2 crenulate, evenly rounded. Epimeron 3, posteroventral corner acute, slightly produced.

Description. Holotype ?female, 6.3 mm. *Antenna 1:* peduncular article 1 about as long as articles 2 and 3 combined, peduncle about twice as long as flagellum; flagellum 4-articulate, article 1 nearly 1.5 times as long as broad, slightly longer than remainder of flagellum; accessory flagellum at least 1-articulate (damaged), reaching ¾ of the way along article 1 of flagellum. *Antenna 2* about as long as antenna 1; flagellum 5-articulate.

Mandible: lacinia mobilis and accessory spines absent; palp 3-articulate, attached just distal to midpoint of dorsal margin, article 2 narrow, subequal in length to article 3 with 4 mediodistal setae, article 3 with rows of minute hairs and at least 6 setae along medial and apical margin. *Maxilla 1:* inner plate long, narrow, no apparent apical setae; outer plate with 5 spine-teeth in a 3/2 formula; palp absent. *Maxilliped:* inner plates absent; outer plates large, reaching to end of article 3 of 4-articulate palp.

Gnathopod 1 subchelate, large; coxa subquadrate, broader than long article 2 as broad as long; article 3 greatly enlarged; article 6 large, about 1.5 times as long as broad, palm transverse, defined by an acutely projecting tooth. *Gnathopod 2* minutely subchelate; article 5 about 1.75 times as long as article 6; article 6 with posterodistal margin naked.

Peraeopod 3: coxa slightly deeper than broad, subquadrate; articles 3 to 6 with sparse setae along posterior margin; article 4 slightly produced anteriorly and subequal in length to article 6; dactyl short. *Peraeopod 4:* coxa about as broad as long, posteroventral lobe weakly produced; in other ways similar to peraeopod 3 except setae along posterior margin of articles 3 to 6 are longer. *Peraeopod 5:* article 2 with posterior margin evenly rounded, crenulate; article 4 slightly expanded posteriorly with several setae along posterior margin. *Peraeopod 6* similar to peraeopod 5 except posterior margin of article 2 straight and broadly rounded distally. *Peraeopod 7:* article 2 larger than article 2 of pereaopods 5 and 6, posterior margin evenly rounded proximally, slightly cut away distally, crenulate; article 4 similar to article 4 of peraeopods 5 and 6.

Uropod 1: peduncle slightly longer than rami, with 3 dorsolateral spines and a pair of apical spines; rami without marginal spines; subequal in length. *Uropod 2* shorter than uropod 1; peduncle longer than rami, with 2 dorsolateral spines and a pair of apical spines; rami without marginal spines; inner ramus slightly longer than outer ramus. *Uropod 3* shorter than uropod 2; peduncle as long as outer ramus; outer ramus 2-articulate, slightly longer than inner ramus. *Telson* slightly longer than broad, entire, slightly rounded distally, with 2 apical setae.

Remarks. *Pachychelium schellenbergi* is very closely related to *P. nichollsi*. They differ in the shape of article 2 on peraeopods 5 to 7.

Distribution. *Pachychelium schellenbergi* is known from Ultima Esperanza, Punta Arenas and Picton Banner Cove in southern South America, 1 to 18 m depth, the Falkland Islands, 1 to 16 m depth, and possibly from South Georgia in 179 to 235 m depth.

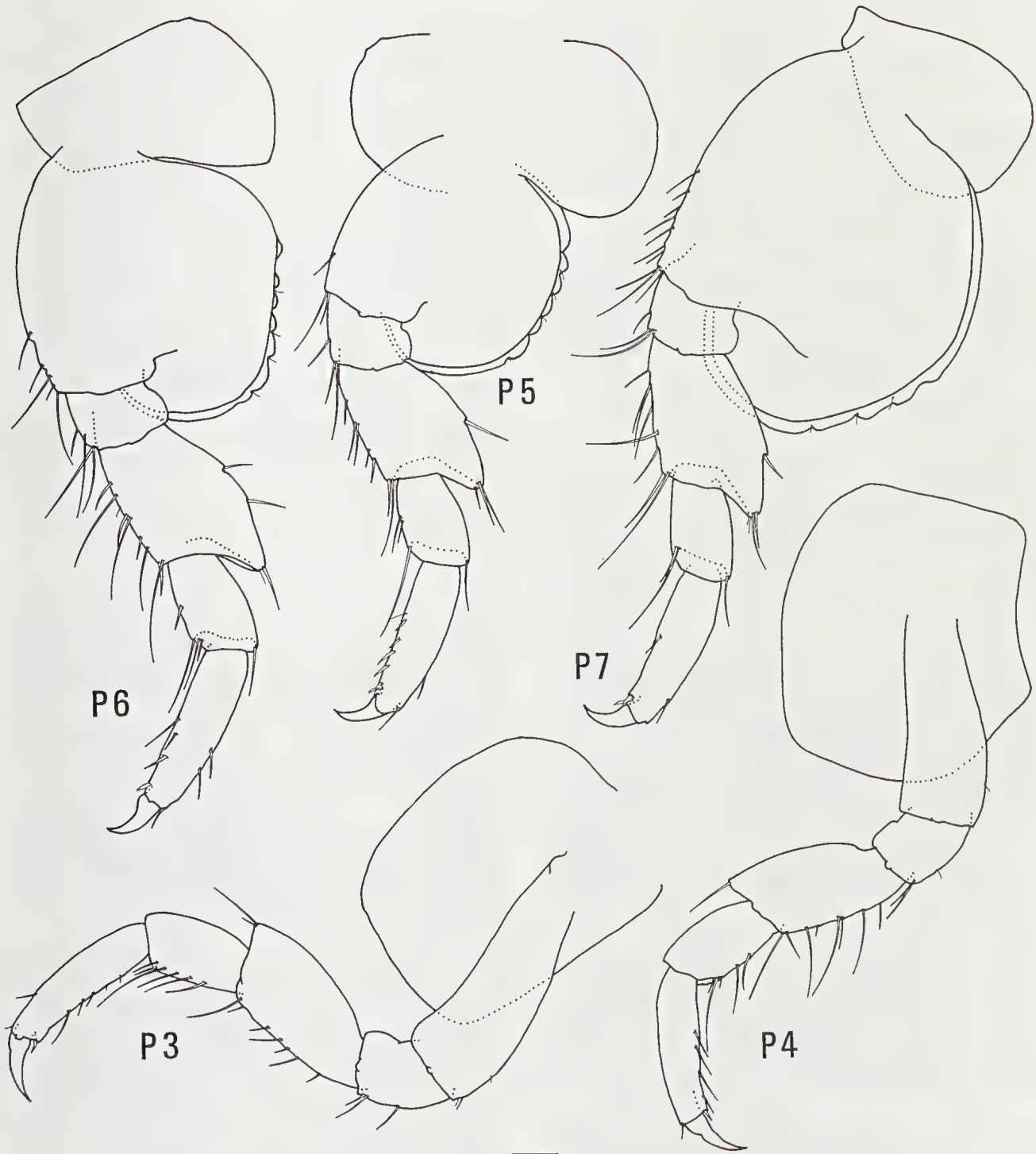

Fig. 41 *Pachychelium schellenbergi* n.sp., holotype, 6.3 mm, Ultima Esperanza, Chile. Scale represents 0.1 mm.

Pachychelium nichollsi n.sp.

Pachychelium antarcticum.—Nicholls, 1938: 14, fig. 3; Bellan-Santini, 1972: 215, pl. 28.

All material of *Pachychelium* from the east Antarctic has been referred to *P. antarcticum*. However the material so well illustrated by Nicholls (1938) and Bellan-Santini (1972) is a distinct new species which I am naming after Dr G.E. Nicholls. Because Nicholl's original material is now lost (Lowry, 1982) the specimen figured by Bellan-Santini (1972) is designated as the holotype. This specimen is in Dr Bellan-Santini's personal collection.

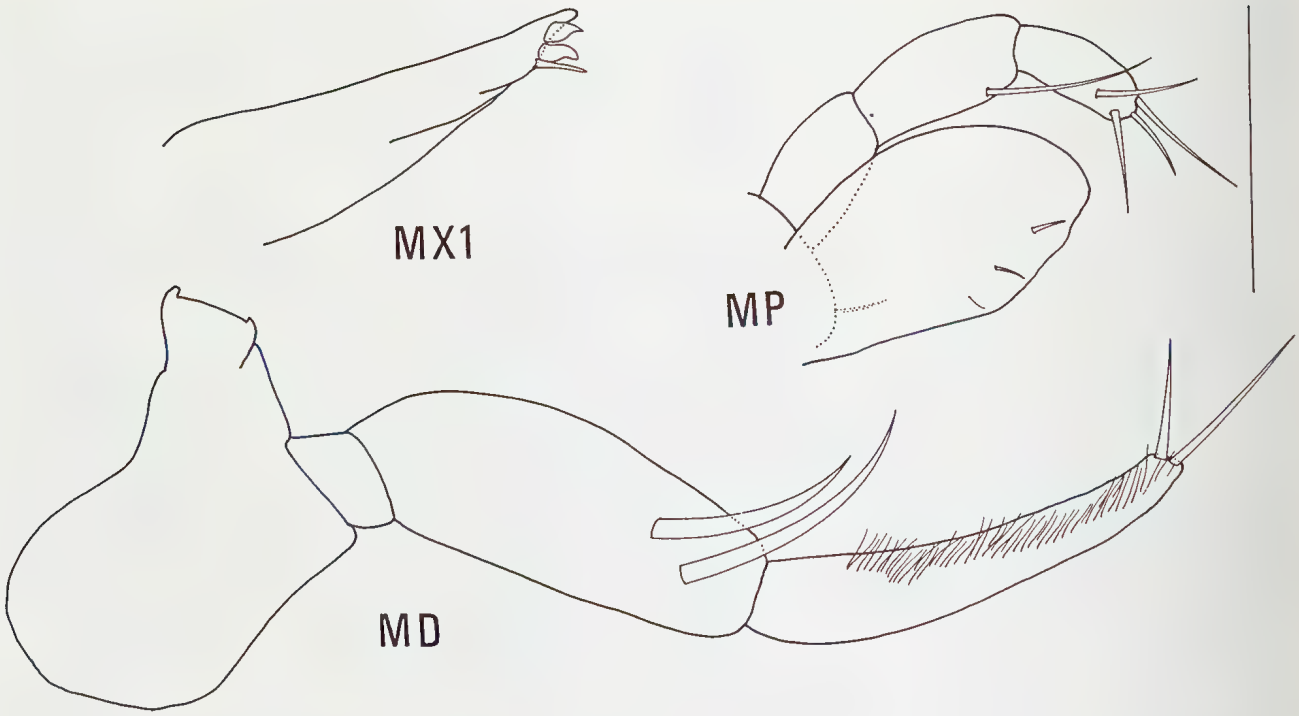

Fig. 42 *Pachychelium davidis* Stephensen, holotype, 3.5 mm, W of Greenland. Scale represents 0.1 mm.

Type-material. HOLOTYPE, Cape Geodesie, Adelie Coast, Antarctica, 66°40′S 139°51′E, pebble and mud bottom on the west side of the hole, 220-240 m, P.M. Arnaud, 26 December 1964, TA-D101 (illustrated in Bellan-Santini, 1972).

Diagnosis. Eyes absent. Maxilla 1, outer plate with a 3/3 spine-tooth formula. Maxilliped with 4-articulate palp. Gnathopod 1 subchelate, palm defined by an acutely projecting tooth. Gnathopod 2 minutely chelate. Peraeopod 7, posterior margin of article 2 straight, crenulate, posteroventral corner sharply rounded. Epimeron 3, posteroventral corner acute, slightly produced.

Remarks. *Pachychelium nichollsi* is very closely related to *P. schellenbergi*. They differ in the shape of article 2 on peraeopods 5 to 7.

Distribution. *Pachychelium nichollsi* is known from Commonwealth Bay, Antarctica, in depths from 45 to 720 m and from Cape Geodesie, Antarctica, in depths from 220 to 240 m.

Pachychelium antarcticum Schellenberg, 1926

Pachychelium antarcticum Schellenberg 1926: 296, fig. 30.—Lowry and Bullock, 1976: 101 (in part).
not *Pachychelium antarcticum*.—Schellenberg, 1931: 19, fig. 8 (= *P. schellenbergi*); Nicholls, 1938: 14, fig. 3 (=*P. nichollsi*); Bellan-Santini, 1972: 215, pl. 28 (= *P. nichollsi*).

Schellenberg's original description of *P. antarcticum* described the maxilliped as having 3-articulate palps and inner plates. Article 2 of peraeopod 7 was illustrated with a rounded posteroventral corner. Schellenberg (1931) had new material from southern South America and the Falkland Islands which had a 4-articulate palp on the maxilliped and no inner plates. Schellenberg indicated that his original description was incorrect in this detail and called all the material *P. antarcticum*. I accept Schellenberg's original description and rediagnose the species.

Diagnosis. Eyes absent. Maxilla 1 unknown. Maxilliped with 3-articulate palp and small inner plates. Gnathopod 1 subchelate. Gnathopod 2 minutely chelate. Peraeopod 7 with article 2 small, less than half length of articles 3 to 7, posterior margin evenly rounded. Epimeron 3, posteroventral corner subacute.

Remarks. *Pachychelium antarcticum* is a poorly known species, but as it is described at present it appears to be most closely related to *P. davidis*. The two species differ in that *P. antarcticum* has small inner plates on the maxilliped. *Pachychelium antarcticum* differs from *P. nichollsi* in the 3-articulate maxillipedal palp and in the size and shape of article 2 on peraeopod 7.

Distribution. *Pachychelium antarcticum* is known from one specimen collected in 385 m depth at Gauss Station, Davis Sea, Antarctica, 66°02′S 89°38′E.

Pachychelium davidis Stephensen, 1925
Fig. 42

Pachychelium davidis Stephensen, 1925: 121, fig. 35.
not *Pachychelium davidis*.—K.H. Barnard 1932: 75, fig. 32 (? = *P. schellenbergi*).

When Stephensen (1925) described *P. davidis* from the Davis Strait off Greenland he did not describe the

mouthparts. This became an increasing problem as more species became known. I was able to borrow Dr Stephensen's unique specimen and describe the mouthparts. The microscope slides of the body appendages are no longer in good condition but Dr Stephensen's drawings of these appendages are excellent.

Material examined. HOLOTYPE, 3.5 mm, ZMC, Danish Ingolf Expedition Station 27, west of Greenland, 64°54'N 55°10'W, 740 m, bottom temperature 3.8°C.

Diagnosis. Eyes absent. Maxilla 1, outer plate with 3/1 spine-tooth formula. Maxilliped with 3-articulate palp. Gnathopod 1 subchelate, posterior margin of palm rounded. Gnathopod 2 minutely subchelate. Peraeopod 7, posterior margin of article 2 evenly rounded. Epimeron 3, posteroventral corner evenly rounded.

Remarks. *Pachychelium davidis* appears to be most closely relatd to *P. antarcticum* from which it differs in not having inner plates on the maxilliped, and to *P. nichollsi* from which it differs in having a 3-articulate maxillipedal palp.

Distribution. Known from one specimen collected from 740 m depth in the Davis Strait off Greenland.

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- 3 MAY 1985
NATURAL HISTORY

Taxonomy and Distribution of *Equitius* in Eastern Australia (Opiliones: Laniatores: Triaenonychidae).

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Sydney South, N.S.W., 2000

ABSTRACT. The genus *Equitius* is revised. *Jenolanicus* Roewer, 1915, *Monacanthobunus* Roewer, 1915, *Monoxyomma* Pocock, 1903 and *Rydrusa* Roewer, 1931 = new synonyms of *Equitius* Simon, 1880. Three new combinations are established: *E. altus* (Forster, 1955) (*Jenolanicus*), *E. spinatus* (Pocock, 1903) (*Monoxyomma*) and *E. tambourineus* (Roewer, 1921) (*Jenolanicus*). Four new synonymies are proposed: *Jenolanicus armatus* Roewer, 1915 and *Monacanthobunus continentalis* Roewer, 1915 = *E. doriae* Simon, 1880; *E. affinis* Roewer, 1923 and *Rydrusa armata* Roewer, 1931 = *E. tambourineus* (Roewer, 1921). Three new species are described: *E. formidabilis*, *E. montanus* and *E. richardsae*. A key to all seven species is given.

Discontinuous mountain blocks and major river valleys are seen as factors influencing the present distribution of species in south-eastern Australia. An isolated cave population of *E. altus* is noted.

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Keywords: Taxonomy, *Equitius*, Opiliones, eastern Australia, speciation, cavernicolous

Equitius is the dominant harvestman genus inhabiting moist forest and woodland in the coastal ranges and plains of south-eastern Australia, from southern Queensland (latitude 27°S) to the Shoalhaven River, N.S.W. (latitude 35°S). Its species are perhaps the commonest large arachnids to be found under logs on the forest floor, but the importance of the genus has not previously been recognised because of failure by authors to recognise the taxonomic unity of these species.

Materials and Methods

Type material of all nominal species has been examined and reassessed. The following abbreviations have been used to indicate the present location of material examined:

AM	The Australian Museum, Sydney
ANIC	Australian National Insect Collection, Canberra
BM	British Museum (Natural History), London
MCSN	Museo Civico di Storia Naturale, Genoa
PM	Muséum National d'Histoire Naturelle, Paris
MV	Museum of Victoria, Melbourne
NHRMS	Naturhistoriska Riksmuseet, Stockholm
NMS	NaturMuseum Senckenberg, Frankfurt am Main
UQ	University of Queensland, Entemology Dept., Brisbane

Terminology closely follows that of Forster (1954). Tergal areas 1–5 are abbreviated to TA1, TA2, etc. Methods of measuring specimens follow Hunt (1979).

Male dimorphism has been noted in all species of *Equitius* except *E. formidabilis* where only small samples are available. The phenomenon is described in detail elsewhere (Hunt, 1979). Form A males, which exhibit normal development of secondary sexual characteritics, are used for the description of males. Form B males show incomplete development of secondary sexual characteristics in body size, robustness of pedipalps and in the size and nature of certain spines on the pedipalps. Form B are not described here as inclusion would make each species description unduly long and complex. The specific status of these males can be determined from male genitalic characters which are the same as in Form A males, or by their presence in a large series of specimens in which the identity of Form A males and females has been determined.

Family Triaenonychidae Soerensen, 1886
Subfamily Triaenonychinae Pocock, 1903
Tribe Triaenonychini Pocock, 1903

Genus *Equitius* Simon, 1880

Equitius Simon, 1880: 100. — Roewer, 1915: 110, 1923: 606.
Type-species: *Equitius doriae* Simon.

Monoxyomma Pocock, 1903: 444. — Roewer, 1915: 111, 1923: 608. — Hickman, 1958: 64. n.syn. Type-species: *Monoxyomma spinatum* Pocock.

Jenolanicus Roewer, 1915: 90, 1923: 598. n.syn. Type-species: *Jenolanicus armatus* Roewer.

Monacanthobunus Roewer, 1915: 103, 1923: 603. n.syn. Type-species *Monacanthobunus continentalis* Roewer.

Rydrusa Roewer, 1931: 171. n.syn. Type-species *Rydrusa armata* Roewer.

Diagnosis. Anterior margin of carapace armed above with variable number of spines or tubercles. Eyemound rising short distance behind anterior margin, armed with strong suberect spine. Scutal groove present mesially; groove between TA4 and TA5 discernible, other tergal grooves indistinct. TAl–4 with mesial pair of spines or tubercles which tend to form a row with smaller granules placed more laterally. Spines on TA3 largest, usually very long. Spines on TA1–2 subequal or either pair larger. Spines on TA4 more widely spaced. TA5 and free tergites each with row of tubercles or granules. Tergal region of scute in Form A males and most Form B males with mesial saddle-like stripe of pigmentation; female with continuous band of pigment in each tergal area across width of scute. Each sternite with row of granules; genital operculum essentially smooth; spiracles partly obscured by bridging tubercles on coxa 4. Chelicera without proximal boss on first segment. Pedipalp femur with proximoventral trifid spine strongly developed in Form A males, less so in Form B males and females; large midventral spine at 0.3–0.5 distance along ventral surface, either smaller or larger than the more proximal spine; dorsal surface usually with row of 4–5 mesial spines and row of 2–5 smaller prolateral spines; prolateral surface of femur and patella both with distal pair of strong spines. Legs: ventral surface of coxa 1 with pair of prodistal spines joined at their bases, and with 2 strong spines and 4 tubercles arising more proximally; femora without large spines or tubercles; calcaneus of metatarsi much shorter than astragalus, that of leg 1 of male with ventral notch. Tarsal formula (distitarsal segments in parentheses): males 4–6(2), 8–15(3), 4, 4; females 3(1), 7–15(3), 4, 4. Penis of simple form; fused ventral plates separated by small distal notch, each plate with 1 superior and 5–6 inferior setae; dorsal plate without deep apical cleft; glans simple, spatulate apically, greater part not enclosed by plates.

Comments. Simon (1880) erected the genus *Equitius* and described *E. doriae*, the type-species, from the Blue Mountains of New South Wales. His unillustrated Latin description referred to the characteristic spine on the eyemound, the ventral notch in metatarsus 1 of the male and the mesial pair of long spines on TA3, but failed to mention the much smaller mesial spines also present on TAl.

Simon's paper appears to have been overlooked by Pocock (1903) when he erected the then monotypic genus *Monoxyomma*. Pocock's excellent description of the type-species, *M. spinatum* Pocock from Hillgrove, near Armidale, northern N.S.W., included most of the characteristic features of *Equitius*. He illustrated the male genitalia, though, unfortunately, not the distinctive pedipalp. He also referred to the presence of the ventral notch on metatarsus 1 of the male by an oblique reference, "protarsus of first (leg) modified as in *Acumontia Majori*". This was noted by Roewer (1915) in his reference to the calcaneus of *M. spinatum* as being ventrally 'ausgebuchtet'; he did not comment on the significance of the notch in pointing to a relationship between *Equitius* and *Monoxyomma*, but instead put emphasis on tarsal segmentation as a generic character. The specimen described by Pocock has 6 segments in the tarsus of leg 1. Roewer (1923) and Forster (1955) used this as a key character to separate *Monoxyomma* from *Equitius*. However, 6 tarsal segments appear to be unusual in *M. spinatum*; in a recent collection of 7 males from the type locality, 2 have 6 segments in tarsus 1 on one side of the body and 5 on the other, while the remainder have 5 segments in both first tarsi. Furthermore, in many populations of *E. doriae*, the number can vary from 4–6. Hickman (1958) found similar variability in many Tasmanian harvestmen. Because of similarities between the holotypes of *M. spinatum* and *E. doriae* in the structure of the male genitalia and pedipalp, *Monoxyomma* must be placed in synonymy with *Equitius*.

While the type-species of *Monoxyomma* must be placed in *Equitius*, the same is not true for two species from Queensland subsequently assigned to *Monoxyomma*. Roewer (1921) described *M. manicatum* Roewer and placed it in this genus on superficial characters, including the presence of more than 5 segments in tarsus 1. Forster (1955) redescribed this species from Roewer's specimens and also described a closely related species, *M. rotundum*. As Forster's figures show, the structure of the male genitalia of both species is unlike that figured by Pocock for *M. spinatum*. These two species also differ markedly from *M. spinatum* in the spination of the pedipalp, in the absence of the ventral notch in metatarsus 1 of the male, and in the absence of spines along the front of the carapace. I consider that these two species should be placed in a new genus together with some undescribed species ranging from northern Queensland to southern N.S.W.

Hickman (1958) placed two new Tasmanian species, *M. cavaticum* and *M. silvaticum*, in *Monoxyomma*, although the males of these also lack the ventral notch in metatarsus 1. The male genitalia are very similar to that of *Equitius*, differing mainly in the presence of a deeply cleft dorsal plate and a marked proximal concavity directed basally in the ventral plates. These species appear to be closely related to the mainland genus *Holonuncia* Forster, but differ in the absence of the metatarsal notch. I consider that they should be placed in a new genus together with *Monacanthobunus tasmanicus* (see below) and some undescribed species from Tasmanian caves.

Roewer (1915) erected the genus *Jenolanicus* for a new species, *J. armatus* from Jenolan Caves, N.S.W.

The type is a female, although Roewer mistakenly identified it as a male. Like females of *Equitius*, it has 3 segments in tarsus 1 and lacks the metatarsal notch. It is not surprising therefore, considering the emphasis he placed on tarsal segmentation as a generic character, that Roewer erected a new genus for this 'male'.

Additional confusion resulted from Simon's (1880) failure to note the mesial pair of spines on TA1 and TA2 of *Equitius*. Roewer (1915, 1921) and Forster (1955) incorrectly used this supposed absence as a further character to separate *Jenolanicus* from *Equitius* when describing *J. armatus, J. tambourineus and J. altus*. Examination of the scute, pedipalp and penis in a large series of both sexes of *J. armatus*, from its type locality, has shown that this species is a synonym of *E. doriae*. Hence *Jenolanicus* must be synonymised and its three species assigned to *Equitius*.

The genus *Monacanthobunus* was erected by Roewer (1915) largely on the basis of tarsal segmentation and in it he placed two new species, *M. continentalis* and *M. tasmanicus*. The type-species, *M. continentalis*, was described from a single male from Bathurst, N.S.W. The holotype is very similar to *E. doriae* in penis and pedipalp structure (c.f. Figs 3A, C; 5I,J). I regard it as a synonym of *E. doriae*, and hence *Monacanthobunus* becomes a synonym of *Equitius*. *Monacanthobunus tasmanicus* belongs in the same new genus as *Monoxyomma cavaticum* and *M. silvaticum*.

Roewer (1931) erected the monotypic genus *Rydrusa* for the species *R. armata* Roewer. The holotype possesses distinctively large spines on TA1 and in other respects, such as spination of the body and pedipalp, is similar to *E. tambourineus*. In his diagnosis of *Rydrusa*, Roewer stated that the genus differs from *Equitius* and *Jenolanicus* by its 4-segmented tarsus 1 and the presence of large mesial spines on TA1. The unreliability of the former character has been discussed (some specimens of *E. tambourineus* examined have 4 segments in tarsus 1). While regarding the second character, Roewer did not specify the large size of spines in his descriptions of *J. tambourineus* (1921) and *E. affinis* (1923) although they are unquestionably large in both type specimens. *Rydrusa* is therefore synonymised with *Equitius*; *R. armata* falls as a synonym of *E. tambourineus* as does *E. affinis*.

Equitius is closely related to *Holonuncia* Forster with which it partly overlaps in distribution. Males of both genera possess genitalia of similar general structure, but in *Holonuncia* the dorsal plate of the penis has a deep apical cleft, while the fused ventral plates have a marked proximal concavity directed basally. Unlike *Equitius*, the eyemound of *Holonuncia* is unarmed or bears only a tubercle, and there are also differences in the spination of the pedipalp. Like *Holonuncia*, *Equitius* is closely related to the Tasmanian species placed by Hickman (1958) in the genus *Monoxyomma* as mentioned above. The Tasmanian species *Paranuncia gigantea* Roewer is also closely related to *Equitius*, but differs in the penis having a very long dorsal plate with a deep apical cleft, and in having only three inferior setae on each ventral plate. Thus *Equitius*, *Holonuncia*, Hickman's Tasmanian species currently placed in *Monoxyomma*, *Monacanthobunus tasmanicus* and *P. gigantea* form a closely related group of genera distributed along coastal eastern Australia from southern Queensland to Tasmania. The undescribed genus to include the two species of *Monoxyomma* from Queensland is quite distinct and not closely related to this group.

The seven species (including three n.spp. described below) currently recognised as belonging in *Equitius* may be distinguished by the following key. Females, and to some extent Form B males of certain species, may be difficult to distinguish on external key characters, but where this can be done 'M + F' is given in parentheses. Where only Form A males can be distinguished, 'A' is given in parentheses. The specific identity of Form B males can be readily verified by examination of the genitalia.

Key to Species of *Equitius*

1. Each anterior corner of carapace with large laterally directed spine above coxa 2 (M+F)..... *E. tambourineus*
—— Anterior corners without such a spine (M+F)..... 2

2. Lateral margin of scute usually with large, laterally directed spine above coxa 3 (M+F); dorsal plate of penis apically bifid, terminating well below superior setae (M)..... *E. richardsae* n.sp.
—— Margin of scute (M+F) and dorsal plate of penis (M) without such structures 3

3. Second spine on proventral margin of pedipalp tarsus larger than other tarsal spines (M+F); fused ventral plate of penis longer than wide in ratio of *c.* 2:1 (M)..... *E. formidabilis* n.sp.
—— Tarsal spines not so developed (M+F); fused ventral plates with ratio length to width <1.5:1 (M)..... 4

4. Spine in prodistal corner of pedipalp tibia, and spine immediately proximal to it, very strong and strongly curved towards the tarsus (A); distal process on trifid spine of pedipalp femur very small or lacking (M+F)..... *E. montanus* n.sp.

——Pedipalp spines not so developed.....5

5. Ratio length of second cheliceral segment to length of scute >0.48:1(A) or 0.45:1(F); penis with glans broad basally, *c.* 0.75 width of fused ventral plates (M).....*E. altus*

——Ratio second segment of chelicera to length of scute <0.48:1(A) or 0.45:1(F); glans not so broad basally (M).....6

6. Midventral spine on pedipalp femur usually much longer than more proximal retroventral spine, and spine in prodistal corner of pedipalp tibia usually very weak (A); dorsal plate of penis attenuated and narrower than base of glans (M).....*E. doriae*

——Midventral spine on pedipalp femur similar in length to, or shorter than, more proximal retroventral spine, and spine in prodistal corner of pedipalp tibia relatively strong (A); dorsal plate of penis as wide as or wider than base of glans and usually terminating in a narrow apical process (M).
.....*E. spinatus*

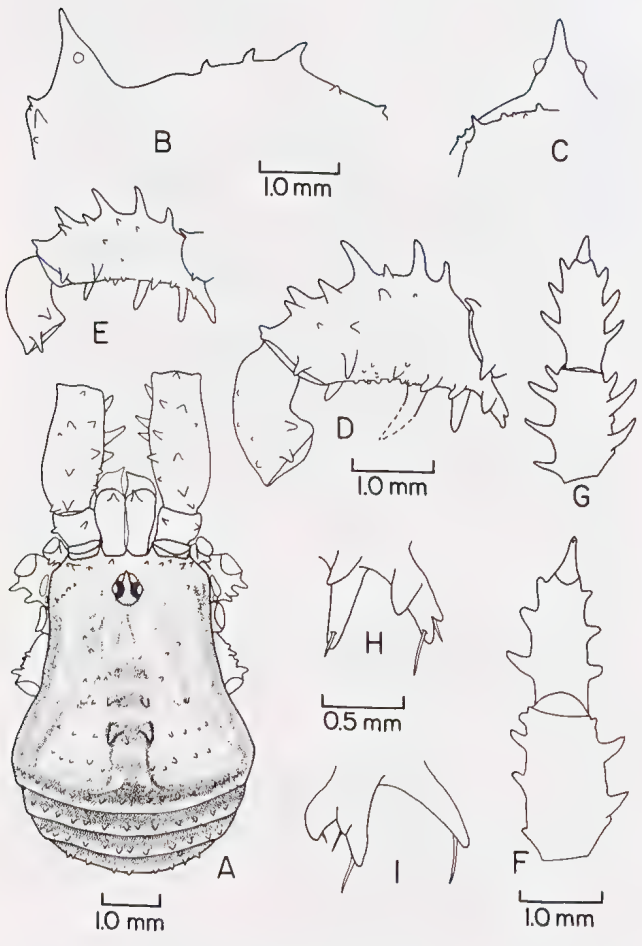

Fig. 1. *Equitius doriae* Simon; male: A–D, F, H–I; female: E,G. **A**, dorsum showing body colour pattern; **B**, lateral profile of scute; **C**, anterior profile of eyemound; **D – E**, prolateral view of pedipalp femur and patella; **F – G**, ventral view of pedipalp tibia and tarsus; **H – I**, proximoventral trifid spine on pedipalp femur; H, prolateral; I, posterior. In this and subsequent figures comparable structures are marked by a single scale bar e.g. B and C, D and E, F and G, H and I.

Equitius doriae Simon, 1880
Figs 1;2;3A–C;5;13A;14A

Equitius Doriae Simon, 1880: 101.
Equitius doriae. — Roewer, 1915: 110, 1923: 607.
Jenolanicus armatus Roewer, 1915: 81, 1923: 598. n.syn.
Monacanthobunus continentalis Roewer, 1915: 103, 1923: 603. n.syn.

Type material. Simon (1880) based his description of *E. doriae* on a series of six specimens and indicated the source of material examined as 'Musée de Genes; obligeamment communiqué par M. le marquis J. Doria'. He did not state that he had selected a holotype, but deposited a single specimen (Form A male) in PM. It bears the label:

'3304- *Equitius doriae* E.S., TYPE

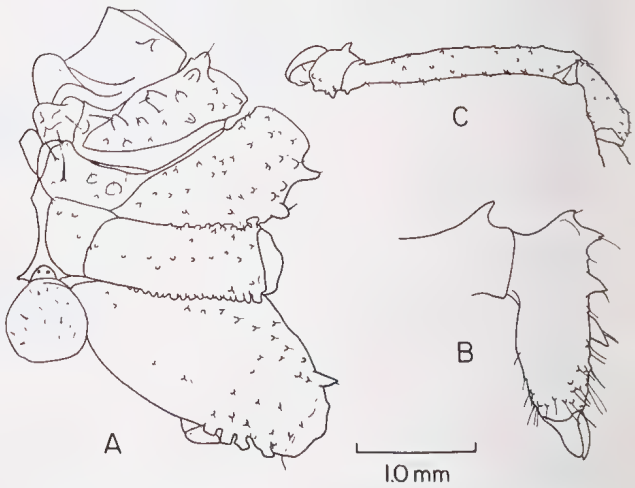

Fig. 2. *Equitius doriae* Simon, male. **A**, coxo-sternal region (left side); **B**, retrolateral view chelicera second segment; **C**, retrolateral view trochanter, femur and patella of leg 1.

Blue Mountains, New Sth. Wales (Doria coll.)'

The remaining five specimens, including a male which I have examined, are all in the same tube in MCSN, with 2 labels:

'Equitius doriae Sim.
Blue Mountains N.S. Wales
racc. L.M. D'Albertis 1873'.

'Equitius doriae Sim tipo.
Simon, C.R. Ent. Belg. XXIII, 1880'.

Accordingly, all specimens should be regarded as syntypes. The PM male has been selected as the lectotype, the MCSN specimens as paralectotypes.

LECTOTYPE. ♂ (here designated): Blue Mountains, N.S.W. (type locality), 1873, L.M. D'Albertis (specimen from Doria Collection), reg. no. 3304, PM.

PARALECTOTYPES: Blue Mountains, N.S.W., 1873, L.M. D'Albertis, MCSN (1 male and 4 other specimens).

Additional material (in AM unless otherwise stated). New South Wales: Bathurst, holotype male of *Monacanthobunus continentalis* Roewer, no. 1035, NMS; Jenolan Caves, holotype female of *Jenolanicus armatus* Roewer, no. 1026, NMS; McKeowns Valley, Jenolan; Mt Victoria, no. 1039, NMS; Mt Victoria, large series in AM; Mt Coricudgy, E. of Rylstone; Mt Coriaday, N. of Mt Coricudgy; Mt Wilson; Mt Irvine; Mt Tomah; Bilpin area; Kurrajong Heights; Newnes Prison Camp area; Lithgow area; Black Range, E. of Jenolan State Forest; Jenolan State Forest; Boyd Plateau (several localities); Kanangra Walls; Mt Shivering, E. of Mt Werong; Wombat Pinch, S. of Mt Werong; Mt Werong pluviometer; Tuglow Hole Mtn, N. of Gurnang State Forest; Gurnang State Forest; Blenheim State Forest, near Oberon; Sunny Corner State Forest, near Kirkconnell; Mt Lambie; Mt Winborndale, N. of Sunny Corner; Mt Canobolas via Orange.

Description. The following redescription is based on the lectotype male in PM and, from the Mt Victoria population, Form A males which show close resemblance to the lectotype. Females of this population are also described. Interpopulational variations show a regional pattern and are outlined separately below.

MALE. *Measurements* (mm) lectotype: scute length 4.22, width 4.24; carapace length 2.06, width 2.92; genital operculum length 0.66, width 0.64; chelicera length, first segment 1.35, second 1.84, total 3.19.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.74	2.76	1.14	2.17	2.67	1.46	12.38
Leg 2	0.85	3.75	1.36	3.27	3.87	3.17	18.55
Leg 3	0.77	3.05	1.07	2.43	2.02	1.55	13.84
Leg 4	0.94	3.68	1.25	3.17	4.43	2.06	17.85
Pedipalp	0.63	2.78	1.68	1.99	–	1.69	9.79

Ranges (mm): length scute 3.91–4.85; length of leg 4 femur 3.51–4.27; length of pedipalp femur 2.27–3.10.

Colour: dorsal pattern of male from Mt Victoria population as in Fig. 1A. Background colour of scute orange-brown with areas of dark-brown to black pigmentation. Dark-brown bars in TA1–4 restricted to mesial saddle, that on TA5 continuous. Free tergites darker than scute. Chelicerae and pedipalps yellow-orange with dark-brown reticulations. Background colour of legs yellowish but largely obscured by dark-brown to black pigmentation.

Body (Fig. 1A–C): eyemound rising short distance behind anterior margin of carapace (Fig. 1B), spine moderately long, eye-level *c.* 0.5 total eyemound height. Viewed anteriorly, lateral edge of eyemound steeply sloping immediately below eyes (Fig. 1C). Anterior margin with 1 prominent spine above each pedipalp coxa and several small tubercles (Fig. 1B,C). Mesial pair of spines on TA2 usually slightly larger than those of TA1. Size and general distribution of other spines, tubercles and granules as in Fig. 1A,B. Coxo-sternal region as in Fig. 2A.

Chelicerae (Figs 1A;2B): first segment short; proportion second segment to scute length 0.44. Second segment with 4 dorsal spines (Fig. 2B) and many setose granules.

Pedipalps (Fig. 1A,D,F,H,I): proportion femur to scute length 0.55–0.60; proportion femur dorsoventral thickness to length 0.47–0.54. Coxa with small distal spine on ventral surface. Trochanter with 3 strong spines: proventral, prodorsal and retroventral. Femur with 5 mediodorsal spines and with row of 3-4 spines more prolaterally (Fig. 1A,D). Ventral surface with a large, proximal, backwardly directed, unevenly trifid spine (Fig. 1D,H) consisting of a main axis and a large proximal and small distal process. Proximal process directed forward forming an angle with the main axis when viewed laterally (Fig. 1H). Posterior view as in Fig. 1I. Retroventral margin of ventral surface with 3 strong spines: first placed immediately distal to trifid spine; second almost midway along surface (termed 'midventral spine' in subsequent descriptions), very strong and curved distad; third weakest and placed in distal half. Proventral margin in proximal half with 3 small spines distal to trifid spine. Prolateral surface with 2 strong distal spines, tip of more proximal spine reaching to below level of ventral surface when viewed laterally. Prolateral surface with other smaller spines and denticles (Fig. 1D), retrolateral surface essentially smooth. Patella with 2 strong prolateral spines (Fig. 1D). Prolateral margin of tibia with 2 prominent spines and small tubercles in distal corner (Fig. 1F, right side). Retrolateral margin with 2 large spines, and small tubercle in proximal and distal corners (Fig. 1F). Pro- and retrolateral margins of tarsus with 3 spines (Fig. 1F). Proportion tarsus breadth to length *c.*1.20.

Legs (Figs 1A; 2A,C): proportion femur leg 4 to scute length 0.84–0.93. Ventral view of coxae shown in Fig. 2A. Spination of retrolateral surface of coxa 2 and prolateral surface of coxa 4 as in Figs 1A, 2A. Coxae 2–4 with numerous granules tending to form rows (Fig. 2A). Trochantera with a few small tubercles, femora with small granules only (Fig. 2C). Ventral notch in calcaneus of leg 1 deep, proximal edge with a small mound before sloping steeply into notch (Figs 13A, 14A). Tarsal formula 4–6, 8–14, 4, 4.

Penis (Fig. 3A–C): shape of fused ventral plates and arrangement of setae as in Fig. 3A,B but both subject to variation (Fig. 5). Dorsal plate (Fig. 3C) relatively long, slender and gently tapering to apex, much narrower than base of glans, apex rounded and reaching

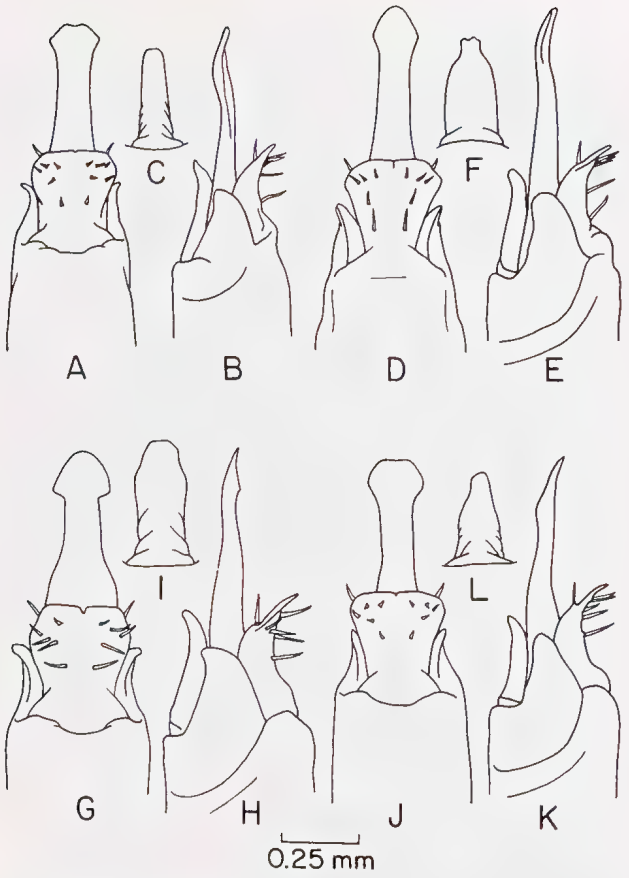

Fig. 3. Distal part of male genitalia of *Equitius* spp: **A–C**, *E. doriae* Simon; **D–F**, *E. spinatus* (Pocock), ex Hillgrove; **G–I**, *E. altus* (Forster); **J–L**, *E. spinatus* (Pocock), ex Barrington Tops. A,D,G,J ventral; B,E,H,K lateral; C,F,I,L dorsal plate.

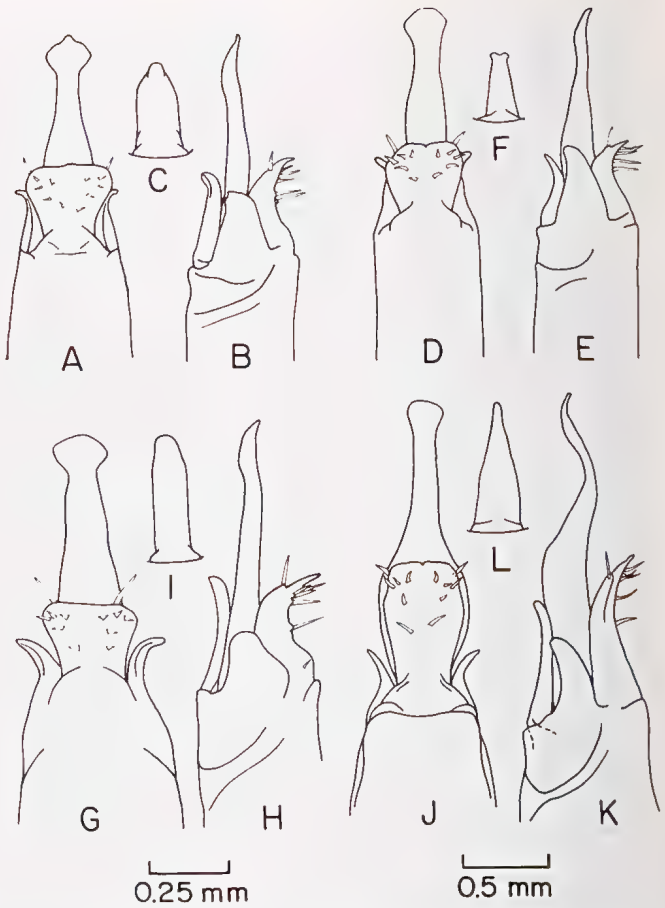

Fig. 4. Distal part of male genitalia of *Equitius* spp: **A–C**, *E. tambourineus* (Roewer); **D–F**, *E. richardsae* n.sp.; **G–I**, *E. montanus* n.sp.; **J–L**, *E. formidabilis* n.sp. A,D,G,J ventral; B,E,H,K lateral; C,F,I,L dorsal plate.

level of superior setae on ventral plate. Lateral plates short, not reaching level of apex of dorsal plate. Glans tapering slightly from base, apex spatulate.

FEMALE (Mt Victoria Population). *Measurements* (mm): scute length 4.15, width 3.85; carapace length 1,72, width 2.56; genital operculum length 0.59, width 0.66; chelicera length, first segment 1.28, second 1.65, total 2.93.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.41	2.22	0.63	1.87	2.16	1.24	8.94
Leg 2	0.57	3.26	0.84	2.93	3.27	2.89	13.86
Leg 3	0.48	2.64	0.55	2.12	2.64	1.56	9.99
Leg 4	0.57	3.42	0.80	2.71	3.88	1.65	13.03
Pedipalp	0.43	2.05	1.17	1.27	–	1.38	6.30

Differs from Form A male in: pedipalp less robust (c.f. Fig. 1E, D); trifid spine on femur and its proximal process less strong (Fig. 1E); midventral spine on femur relatively weak; proximal retroventral and distal pro- and retroventral spines on tibia relatively long (Fig. 1G). Tarsal formula: 3, 7–13, 4, 4.

Variations. The following important variations from the lectotype and males of the Mt Victoria population have been noted. Scute length 3.71–5.07 mm; proportion pedipalp femur length to scute length 0.53–0.70; leg 4 femur length to scute length 0.72–1.01.

Populations collected from rainforest or semirainforest (Mt Coriaday, Mt Coricudgy, Mt Wilson, Mt Irvine, Mt Tomah and Kurrajong Heights) tend to have the following: midventral spine on pedipalp femur often relatively small, of similar size to more proximal retroventral spine, but large in some individuals; proximal process of trifid spine usually large and parallel to main axis (but not parallel in Kurrajong Heights population); spines in distal corners of pedipalp tibia slightly longer; the most proximal dorsal spine along pedipalp femur often lacking; both prodistal spines on pedipalp femur often not reaching level of ventral surface when viewed laterally. In the Mt Canobolas population proximal process of trifid spine large and parallel to main axis. The Oberon, Gurnang State Forest, Tuglow Hole Mountain and Mt Werong populations tend to have 4 rather than 5 segments in tarsus 1 and somewhat shorter spines on the eyemound and TA3. Minor variations occur in the structure of the penis (Fig. 5). Usually each ventral plate has 5 inferior setae, but the Lithgow specimen of Fig. 5 has 5 on the left side and 6 on the right, whilst the Mt Wilson specimen has 6 on both plates. This type of variation appears to be typical of *Equitius* spp. The shape of the ventral plate also varies, for in the Mt Victoria specimen illustrated it is relatively narrow near its base, but in

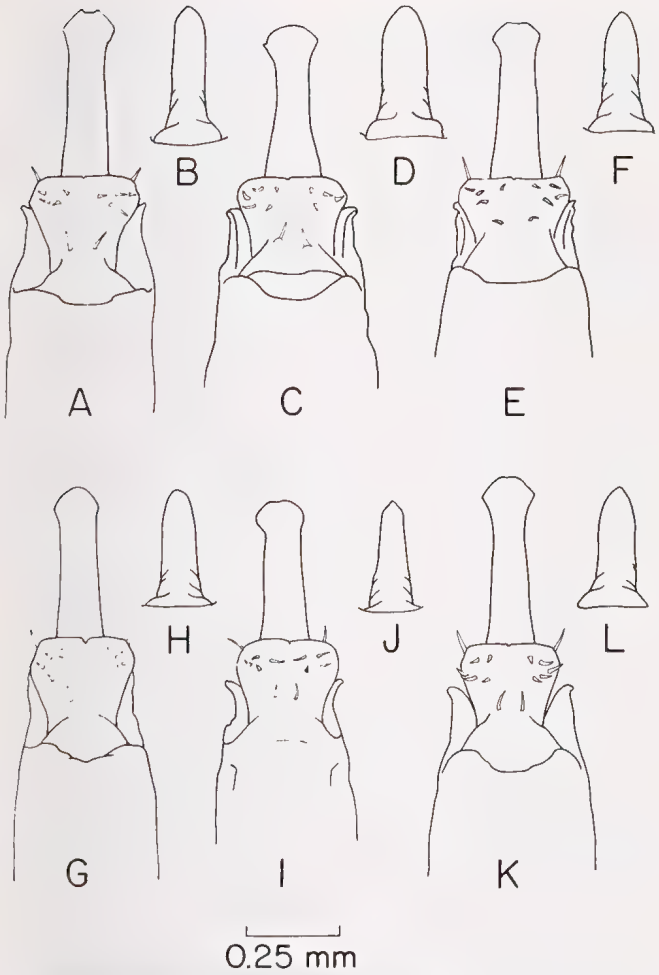

Fig. 5. Variation in distal part of male genitalia, *Equitius doriae* Simon. **A–B**, ex Mt Victoria; **C–D**, ex Lithgow; **E–F**, ex Jenolan Caves; **G–H**, ex Oberon; **I–J**, holotype *Monacanthobunus continentalis* Roewer; **K–L**, ex Mt Wilson. A,C,E,G,I,K ventral; B,D,F,H,J,L dorsal plate.

others examined from the population it is relatively wide. The size and shape of the dorsal plate varies slightly, but in all cases is relatively elongate and narrower than the base of the glans.

Distribution. N.S.W., in mountain and plateaux country north of Goulburn and south of the Hunter River, with an outlier population at Mt Canobolas, near Orange. Most common in rainforest, wet sclerophyll forest, or snow-gum woodland.

Comments. Roewer (1915) redescribed *E. doriae* from a male and a female collected at the foot of Mt Townsend, N.S.W.; he did not examine the syntypes. This locality is in the Snowy Mountains, over 100 kilometres south of other known records of *Equitius*. No specimens labelled as *E. doriae* from this locality have been located in NMS but 2 males labelled as follows have been examined.

'*Equitius doriae* Simon
1 ♂, 1 ♀. N.S. Wales, Mt Victoria
Roewer det. 1914 No. 1039'.

The registration number indicates this is the material Roewer (1915) described and that the Mt Townsend record is an error (Hunt, 1979). The specimens (Roewer

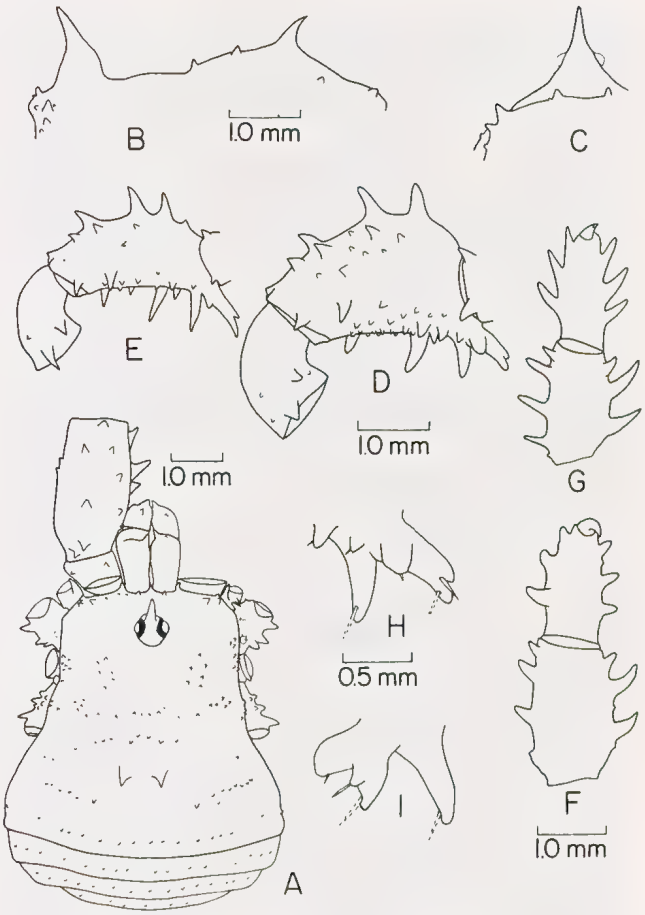

Fig. 6. *Equitius spinatus* (Pocock); male: A–D,F,H–I; female: E,G. **A**, dorsum; **B**, lateral profile of scute; **C**, anterior profile of eyemound; **D – E**, prolateral view of pedipalp femur and patella; **F – G**, ventral view of pedipalp tibia and tarsus; **H – I**proximoventral trifid spine on pedipalp femur: H, prolateral; I, posterior.

coll. No. 302/1) identified as belonging to *E. doriae* by Roewer (1931) belong to *E. tambourineus*. The three males and three females identified in the same paper as *E. doriae* and said to be housed in PM (Coll. Simon No. 18082) cannot be located.

Equitius doriae appears to be most closely related to *E. spinatus*, but differs from it in the shape of the dorsal plate of the penis and in the strength of the midventral spine on the pedipalp femur. The structure of the pedipalp of *E. doriae* closely resembles that of *E. richardsae* but the latter differs in penis structure with a short, apically bifid dorsal plate.

Equitius spinatus (Pocock), 1903, n.comb
Figs 3D-F,J-L; 6;13B-C

Monoxyomma spinatum Pocock, 1903: 445 and plate XI. — Roewer, 1915: 112, 1923: 608.

Type material. HOLOTYPE ♂: Hillgrove, N.S.W., 1894, R. Broom, BM.

Additional material (in AM unless otherwise stated). New South Wales: Hillgrove; Narrow-Neck saddle, S. of Hillgrove; Brissey State Forest, E. of Yarrowitch; Upper Tia River at crossing of Nowendoc Rd; Black Sugarloaf, Nowendoc-Walcha Rd; Mountain Creek, 42 km N. of Gloucester;

Barrington Tops (UQ and AM); Tubrabucca, Barrington Tops; Pacific Hwy, 10 km S. of Kempsey; Carrai Bat Cave area; Carrai Plateau (UQ); Wittitrin, W. of Kempsey; Corner Pacific and Oxley Hwy, Wauchope; Wilson River Flora Reserve via Wauchope; O'Sullivan's Gap Flora Reserve via Bulahdelah; Smiths Lake and Boolambayte Lake, via Bulahdelah.

Description. The following redescription is based on the holotype male and further material from type locality.

MALE: As in *E. doriae* except as set out below.

Measurements (mm) holotype: scute length 5.05, width 4.98; carapace length 2.38, width 3.56; genital operculum missing but measurements for male from same locality with scute length 5.15 are length 0.79, width 0.85; chelicera length, first segment 1.43, second 2.18, total 3.61.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.80	3.55	1.30	2.82	3.56	1.83	13.14
Leg 2	0.95	5.13	1.57	4.53	5.83	2.88	20.89
Leg 3	0.91	4.15	1.35	3.08	4.38	2.27	16.14
Leg 4	1.06	5.35	1.61	3.94	6.56	2.75	21.27
Pedipalp	0.84	3.37	1.98	1.94	-	2.05	10.17

Ranges (mm): length scute 4.88–5.07, length leg 4 femur 4.77–5.35, length pedipalp femur 3.04–3.37.

Colour: orange-brown with reddish and brown markings; free tergites darker; chelicerae and pedipalps orange with reddish-brown reticulations; legs yellowish with dark-brown markings.

Body (Fig. 6A–C): large, scute wide, eyemound spine long, eye-level *c.* 0.35 total eyemound height (Fig. 6B). Viewed anteriorly, lateral edge of eyemound sloping gradually from immediately below eyes (Fig. 6C). Mesial pair of tubercles on TA1 and TA2 relatively much smaller than those on TA3.

Pedipalps (Fig. 6A,D,F,H,I): proportion femur length to scute length 0.62–0.67; femur robust, proportion of dorsoventral thickness to length *c.* 0.59. Dorsum of femur rising more abruptly from articulation with trochanter. Midventral spine only marginally larger than more proximal retroventral spine. Tips of 2 distal spines on prolateral surface not reaching level of ventral surface when viewed laterally. Spines in both distal corners of tibia relatively well developed.

Legs: very long, proportion leg 4 femur to scute length 0.98–1.06. Calcaneus of leg 1 more robust; ventral notch deep and with steep proximal slope, mound on proximal edge prominent (Fig. 13B). Tarsal formula: 4–6, 9–15, 4, 4.

Penis (Fig. 3D–F): shape of fused ventral plates and arrangement of setae as in Fig. 3D,E, both subject to variation. Dorsal plate (Fig. 3F) broad, wider than base of glans; sides subparallel in proximal half, but beyond tapering to a short apical process reaching level of superior setae.

FEMALE. Differs from male in same respects as does that of *E. doriae*. Tarsal formula: 3, 7–13, 4, 4.

Variations. Scute length 3.85–5.07 mm. Proportion pedipalp femur length to scute length 0.58–0.68; leg 4 femur length to scute length 0.76–1.07. Most populations, particularly that from O'Sullivans Gap, are more melanic than the Hillgrove population. At both Hillgrove and Barrington Tops the proximal process on the trifid spine of the pedipalp femur forms an angle with the main axis of the spine whilst in other populations it is subparallel to the main axis, though there are occasional individuals in which it forms an angle. In the Hillgrove population, there are usually 4 dorsal spines along the pedipalp femur, though some individuals have 5. In most other populations 5 is usual, though at Wittitrin near Kempsey 4 seems usual. In most populations the normal number of segments in tarsus 1 is 5, but in the Barrington Tops, Nowendoc and Upper Tia River populations this is usually 4. The Hillgrove populations differ from most others in having relatively long legs. The notch in the calcaneus of leg 1 is less pronounced in the Mountain Creek population. At present, none of these variations are regarded as consistent or important enough to erect separate species.

The dorsal plate of the penis figured by Pocock (1903) is slightly bifid as in *E. richardsae* but this condition has not been noted in other males from the type locality.

The populations mentioned above are at present grouped as *E. spinatus* because of basic similarities in the structure of the penis. They occur in a variety of habitats from rainforest to snow-gum woodland, with altitude ranging from sea level to 1,600 m. They also cover a wide geographic area with the type locality at the northern known limit. Therefore, it is possible that some of the populations may prove to be separate species.

Distribution. N.S.W., north of the Hunter River and south of the Hastings River, generally in mountain and plateaux country but also in low-lying moist habitats near coast. The northern-most record is Hillgrove.

Comments. *Equitius spinatus* shows affinities with several species, perhaps because of its relatively generalised morphology without any remarkable modifications. In overall penis structure it resembles *E. tambourineus*, *E. montanus* and *E. doriae*, but differs from the last two in having a broad dorsal plate terminating in a narrow apical process, and from *E. tambourineus* in the general shape of the glans apex. Externally, it shows a general similarity to *E. montanus* including the very deep notch on metatarsus 1, but the latter species differs in the structure of the trifid spine on the pedipalp femur and the prolateral spines on the pedipalp tibia.

Equitius altus (Forster). 1955, n.comb.
Figs 3G–I;7;13D;14B

Jenolanicus altus Forster, 1955: 394.

Type material. HOLOTYPE and 1 PARATYPE male: N.S.W. Barrington Tops, Jan 1925, C. Barrett, MV. Paratype is here designated as belonging to *E. spinatus*.

Additional material (all in AM). New South Wales:

Barrington Tops; Tubrabucca, Barrington Tops; Lister Park via Upper Allyn; Bald Knob area, via Upper Allyn; Big Gum Tree Reserve, SW of Kew; Carrai Bat Cave, W. of Kempsey.

Description. The following redescription is based on the Holotype and further material collected at the Barrington Tops area.

MALE. As in *E. doriae* except as set out below.

Measurements (mm) holotype: scute length 5.02, width 4.45; carapace length 2.45, width 3.55; genital operculum missing; chelicera length, first segment 1.87, second 2.67, total 4.54.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.63	3.44	1.04	2.75	3.37	1.74	12.97
Leg 2	0.81	4.75	1.35	4.30	5.28	4.15	20.64
Leg 3	0.80	3.77	1.28	3.02	3.90	2.16	14.93
Leg 4	0.95	4.60	1.11	3.85	5.90	2.55	18.98
Pedipalp	0.63	3.46	2.12	2.07	–	2.20	10.48

Ranges (mm): length scute 5.02–5.32, length leg 4 femur 4.60–5.13, length pedipalp femur 3.46–3.70.

Colour: pattern of scute as in Fig. 7A.

Body (Fig. 7 A–C): very large. Eyemound high and relatively narrow when viewed laterally (Fig. 7B); eye-level *c.* 0.35 total eyemound height. Viewed anteriorly, lateral edge of eyemound slopes gradually immediately below eyes (Fig. 7C). Mesial pair of tubercules on TA1 and TA2 small and about equal in size; mesial spines on TA3 long.

Chelicerae: very long; proportion second segment to scute length *c.* 0.53.

Pedipalp (Fig. 7A,D,F,H,I): relatively long; proportion femur to scute length 0.67–0.72; proportion femur dorsoventral thickness to length 0.54–0.58. Femur with 4 mediodorsal spines (Fig. 7A,D). Shape of proximoventral trifid spine as in Fig. 7D,H,I; proximal process strong. Midventral spine similar in size to more proximal retroventral spine. Tips of 2 distal spines on prolateral surface failing to reach level of ventral surface when viewed laterally (Fig. 7D). The most distal ventral spine just proximal to distal spines on prolateral surface.

Legs: proportion leg 4 femur to scute length 0.89–0.97. Proximal side of ventral notch in calcaneus of leg 1 not sloping steeply, of similar degree to distal side; proximal mound small (Figs 13D; 15B). Tarsal formula: 5–6, 12–16, 4, 7.

Penis (Fig. 3G–I): ventral plates more rounded when viewed ventrally, apical notch prominent, setae strong. Dorsal plate long, apex reaching beyond level of base of superior setae, wide though not as wide as base of glans, narrowing subproximally and slightly widening subdistally. Glans very wide basally and *c.* 0.75 width of ventral plates, narrowing quickly subapically before expanding into a markedly spatulate apex.

FEMALE. Chelicerae relatively shorter than male but otherwise differs from male in same respects as does that of *E. doriae*. Tarsal formula: 3, 10–12, 4, 4.

Variations. Specimens from the Carrai Bat Cave population are less pigmented and have attenuated legs, proportion leg 4 femur length to scute length for 2 measured males 1.18 and 1.24. Otherwise, individuals resemble the surface form.

Distribution. N.S.W., apparently disjunct. Subtropical and temperate rainforest in the Upper Allyn–Barrington Tops area, north of Hunter Valley; subtropical rainforest in Big Gum Tree Reserve, SW of Kew; cavernicolous population in Carrai Bat Cave W. of Kempsey.

Comments. *Equitius altus* resembles *E. spinatus* in external appearance, but is much larger. It differs from *E. spinatus* in having relatively long chelicerae and a notch in metatarsus 1 without a steep proximal slope. It differs from all species in details of penis structure. The specific name '*altus*' is something of a misnomer, for *E. spinatus* is the more common species at high altitude on Barrington Tops. *E. altus* occurs, almost to the exclusion of *E. spinatus*, in *Nothofagus* beech forest and subtropical rainforest at lower altitudes.

Known surface populations appear to have comparatively localised distributions in the Barrington Tops area and in the Big Gum Tree Reserve area 120 km to the ENE. The Carrai Bat Cave population is situated about 140 km to the NE of Barrington Tops and about 90 km NW of Big Gum Tree. (*E. spinatus* appears to occupy most of the intervening country). Although the Carrai population is possibly a relict, restricted to this cave or caves in the area, the possibility remains that surface populations will be found. Apart from moderate depigmentation and attenuation of the legs, typical of a cavernicole, no other important differences from the surface form were noted. The status of the cave form may be better understood when its biology is investigated and if more extensive collecting reveals other cave or surface populations.

Localised sympatry between *E. altus* and *E. spinatus* has led to some taxonomic confusion. Forster (1955) believed that the male specimen he designated as the paratype of *E. altus* could represent a Form B male, and hence may have been the first record of male dimorphism in Australia. In fact, this specimen is a Form A male of *E. spinatus*. Forster's (1955) measurements appear to have been made on this paratype and not the holotype as implied in his paper. Interestingly, although Forster wrongly identified male dimorphism in the specimens available to him, both species are now known to have Form A and Form B males.

Equitius tambourineus (Roewer), 1921, n.comb.

Figs 4A-C;8;13E;14C

Jenolanicus tambourineus Roewer, 1921: 5. — Forster 1955: 392.
Equitius affinis Roewer, 1923: 607. n.syn.
Rydrusa armata Roewer, 1931: 171. n.syn.

Type material. HOLOTYPE ♀: Mt Tamborine, Queensland, *c.* 1920, Mjöberg, Roewer coll. no. 4761, NHRMS.

Additional material (in AM unless otherwise indicated).

Queensland: Winton, holotype male of *E. affinis*, Roewer coll. no. 303(2), NMS and holotype male of *Rydrusa armata* (not female as stated by Roewer (1931)), Roewer coll. no. 1291/33, NMS; Tamborine, UQ; Mt Lamington; Mt Superbus via Boonah, UQ; Bald Mtn via Emu Vale, UQ.

New South Wales: Upper Coopers Creek, and Coopers Creek, via Huonbrook; N.S.W. (no other data), Roewer coll. no. 302/1, NMS (wrongly identified by Roewer (1931) as *E. doriae*).

'Süd-Australien': no other data, Roewer coll. 5369/40, NMS.

Description. The following redescription is based on the holotypes of *J. tambourineus* and *E. affinis* and on further material from the type locality, Mt Tamborine.

MALE. As in *E. doriae* except as set out below.

Measurements (mm) (Holotype male of *E. affinis*): scute length 4.15, width 3.92; carapace length 1.87, width 2.88; genitial operculum length 0.61, width 0.59; chelicera length, first segment 1.24, second 1.90, total 3.14.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.52	2.45	0.70	1.98	2.53	1.46	9.64
Leg 2	0.63	3.66	0.95	3.35	4.07	3.22	15.88
Leg 3	0.55	2.90	0.70	2.31	3.11	1.57	11.14
Leg 4	0.55	3.73	0.80	2.86	4.40	2.09	14.43
Pedipalp	0.44	2.67	1.65	1.65	–	1.64	8.05

Ranges (mm): length scute 3.43–3.85, length leg 4 femur 3.57–3.81, length pedipalp femur 2.23–2.69.

Colour: pattern of dorsum as in Fig. 8A, reticulations on pedipalps more melanic than in most populations of *E. doriae*.

Body (Fig. 8A–C): small; eyemound rising just behind anterior margin of carapace but sloping more gradually than in *E. doriae* (Fig. 8B); spine very long with eyelevel *c.* 0.30 total eyemound height (Fig. 8B). Viewed anteriorly, lateral edge of eyemound sloping gradually below eyes (Fig. 8C). Spines arranged on dorsum as in Fig. 8A, very strongly developed in comparison with *E. doriae*. Prominent, laterally directed spine near anterior corner of carapace above coxa 2; small spine on lateral margin above coxa 3. Mesial pair of spines on TA3 very long, mesial pair of spines on TAl very strong, those on TA2 much shorter. Spines on posterior margin of scute and on each free tergite very strong.

Chelicerae: distal half of first segment robust.

Pedipalps (Fig. 8A,D,F,H,I): femur relatively long and robust; proportion femur to scute length 0.65–0.70; proportion femur dorsoventral thickness to length 0.52–0.59. Femur with 4 mediodorsal spines, with 2–3 spines placed more prolaterally (Fig. 8A,D). Midventral spine only slightly larger than more proximal retroventral spine. On prolateral surface, tips of 2 distal spines not reaching level of ventral surface when viewed laterally (Fig. 8D).

Legs: long, ratio femur 4 to scute length 0.98–1.04. Ventral notch on metatarsus 1 not deep and without conspicuous mound on proximal edge (Figs 13E; 14C). Calcaneus very short, <0.25 astragalus length. Tarsal formula 4–5, 11–12, 4, 4.

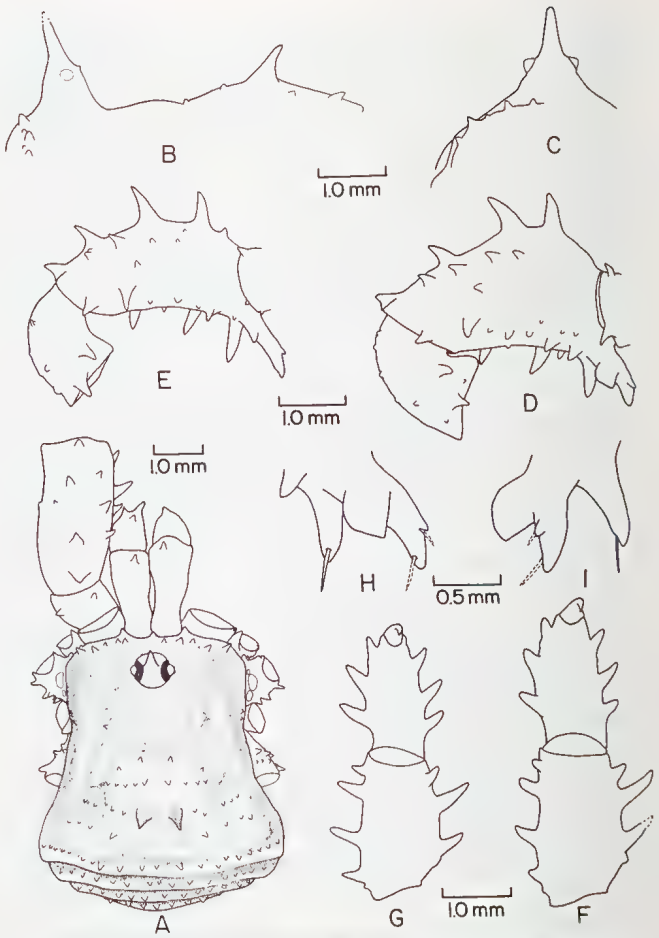

Fig. 7. *Equitius altus* (Forster); male: A–D,F,H–I; female: E, G. **A**, dorsum showing body colour pattern; **B**, lateral profile of scute; **C** anterior profile of eyemound; **D – E**, prolateral view of pedipalp femur and patella; **F – G**, ventral view of pedipalp tibia and tarsus; **H – I**, proximoventral trifid spine on pedipalp femur: H, prolateral; I, posterior.

Penis (Fig. 4A–C): shape of fused ventral plates and arrangement of setae as in Fig. 4A,B, but both subject to minor variation. Dorsal plate (Fig. 4C) as broad as base of glans, sides subparallel but distally tapering rapidly to an apical process. Glans narrow subapically, apex markedly spatulate (Fig. 4A).

FEMALE. *Measurements* (mm) holotype: scute length 3.24, width 3.26; carapace length 1.54, width 2.38; genital operculum length 0.55, width 0.55; chelicera length, first segment 0.84, second 1.50, total 2.34.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.55	2.05	0.80	1.76	2.12	1.13	8.41
Leg 2	0.73	3.19	1.13	2.89	3.44	2.82	14.20
Leg 3	0.73	2.49	0.87	2.01	2.73	1.54	10.37
Leg 4	0.80	3.31	1.02	2.53	3.92	1.68	13.26
Pedipalp	0.44	1.91	1.15	1.17	–	1.24	5.91

Differs from male as does that of *E. doriae*. Tarsal formula: 3, 9–11, 4, 4.

Variations. Scute length 3.43–4.11 mm. In the Bald Mountain population, at the western extent of the known range of *E. tambourineus*, the mesial spines on

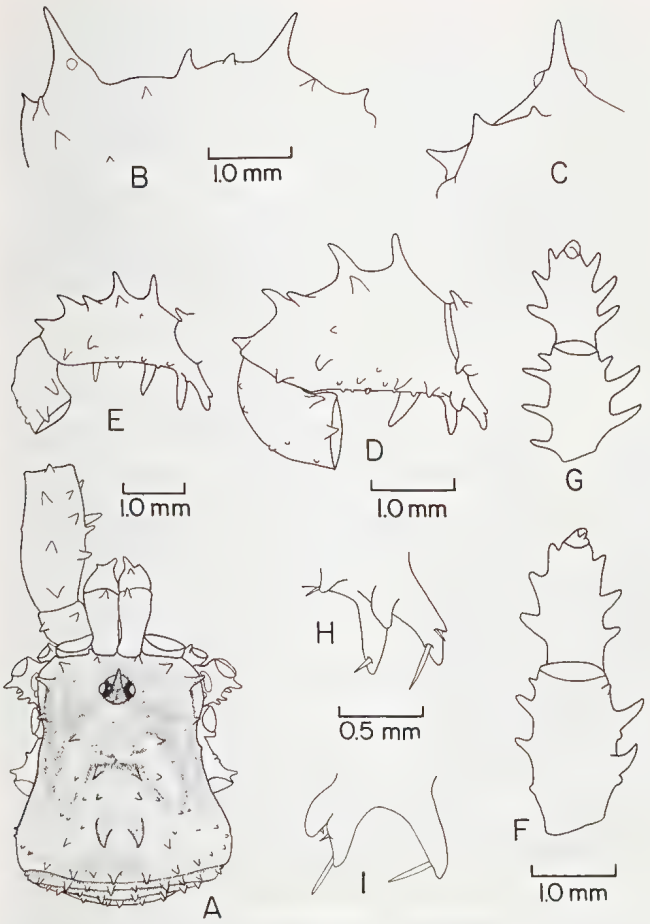

Fig. 8. *Equitius tambourineus* (Roewer), male: A–D,F,H–I; female: E,G. **A**, dorsum showing body colour pattern; **B**, lateral profile of scute; **C**, anterior profile of eyemound; **D – E**, prolateral view of pedipalp femur and patella; **F – G**, ventral view of pedipalp tibia and tarsus; **H – I**, proximoventral trifid spine on pedipalp femur: H, prolateral; I, posterior.

TA1 are nearly equal in size to those on TA2.

Distribution. Coastal ranges northwards from Richmond River, N.S.W., to Mt Tamborine, S.E. Queensland. Western-most record Mt Superbus, via Boonah, Queensland (the records from Winton, in the semi-arid region of Queensland, are probably in error).

Comments. Roewer (1923) described *E. affinis* from a single male ostensibly collected at Winton in western Queensland. This male was compared with males of *E. tambourineus* collected from the type locality. Both possess a penis and pedipalp of similar structure and have the highly characteristic strong spines on the margins of the carapace above coxa 2 and on TA1 (the latter overlooked by Roewer in his description of *E. affinis*). *Equitius affinis* must therefore be regarded as a synonym of *E. tambourineus*.

Both *E. tambourineus* and the geographically adjacent *E. richardsae* show unusual development of spines along the lateral margin of the carapace above coxae 2 and 3 respectively, suggesting a possible relationship. The difference in location of the strong spines may be due to a difference in some growth gradient in this part of the body. The genitalia of the latter species, however, is quite distinctive. *Equitius tambourineus* and *E. richardsae* apparently occur sympatrically in the Bald Mountain area, south-east Queensland.

Equitius tambourineus resembles *E. spinatus* in penis structure, especially in the shape of the dorsal plate. Many populations of *E. spinatus* also have larger spines on TA1 than TA2. *Equitius tambourineus* can be readily distinguished from all other species by the large spines on the lateral margin of the carapace above coxa 2 and the very large mesial spines on TA1.

Equitius richardsae n.sp.

Figs 4D–F;9;13F

Type material. HOLOTYPE ♂: Dorrigo National Park, Dorrigo, N.S.W., subtropical rainforest, 30 August 69, G.S Hunt, AM, No. KS 6484.

PARATYPES (collected G.S. Hunt, in AM except as indicated). New South Wales: Dorrigo National Park, subtropical rainforest, 30 August 69, ♀, KS 6485; Dorrigo–Ebor Rd, 26 km W. of Dorrigo, subtropical rainforest, 30 August 69, 1 ♂, 6 ♀, KS 6486–7; Gibraltar Range National Park, W. of Grafton, subtropical rainforest, 11 January 70, 2 ♂, 3 ♀, KS 6488; same data, 1 ♂, 1 ♀, ANIC; same locality (in earth bank), *c.* 1975, M.R. Gray, 1 ♂, KS 6500; 4 km W. of Nambucca Heads, wet sclerophyll, 10 January 81, 1 ♂, 1 ♀, KS 6489; Bruxner Park, via Coffs Harbour, subtropical rainforest 15 April 68, G. Monteith, 2 ♂, 4 ♀ UQ; Mt Lindesay via Woodenbong, subtropical rainforest, 14 January 81, 1 ♂, KS 6490; Tooloom Scrub via Woodenbong, 26–27 February 68, B. Cantrell, 5 ♂, 6♀, UQ.

Queensland: Bald Mountain, via Emu Vale, 17–22 May 69, B. Cantrell 2 ♂, 1 ♀, UQ.

Additional material. New South Wales: Raspberry Rd, via Jeogla, subtropical rainforest, 1 November 69; Jeogla area, cnr Kempsey Road & Forest Road, wet sclerophyll, 4 January 80.

Description. MALE. As in *E. doriae* except as set out below.

Measurements (mm) holotype: scute length 4.30, width 3.92; carapace length 1.76, width 2.06; genital operculum length 0.66, width 0.64; chelicera length, first segment 1.39, second 1.90, total 3.29.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.55	2.67	0.66	2.09	2.56	1.44	9.97
Leg 2	0.65	3.85	0.98	3.37	4.10	3.55	16.50
Leg 3	0.55	3.00	0.70	2.31	3.04	1.76	11.36
Leg 4	0.55	3.70	0.75	3.00	4.38	2.38	14.76
Pedipalp	0.59	2.82	1.68	1.63	-	1.68	8.37

Ranges (mm): length scute 3.60–4.53; length leg 4 femur 3.19–4.10, length pedipalp femur 2.16–2.89.

Colour: scute orange-brown with areas of dark-brown to black pigmentation. Chelicerae and pedipalps yellow-brown with dark-brown reticulations. Legs yellowish with dark-brown markings.

Body (Fig. 9A–C): eyemound spine long and slender, eye-level *c.* 0.3 total eyemound height. Lateral margin with prominent laterally directed spine above coxa 3. Spine on TA3 relatively long; spines on TA5 and free tergites strong.

Pedipalps (Fig. 9A,D,F,H,I): proportion femur to scute length 0.58–0.68; proportion femur dorsoventral

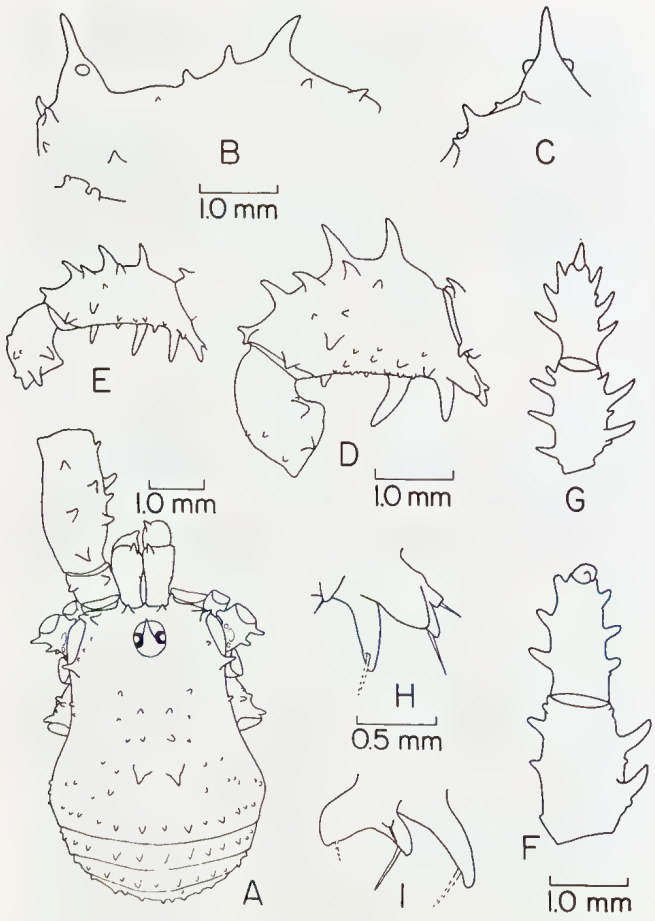

Fig. 9. *Equitius richardsae* n.sp.; male: A–D,F,H–I; female: E,G. **A**, dorsum; **B**, lateral profile of scute; **C**, anterior profile of eyemound; **D – E**, prolateral view of pedipalp femur and patella; **F – G**, ventral view of pedipalp tibia and tarsus; **H – I**, proximoventral trifid spine on pedipalp femur: H, prolateral; I, posterior.

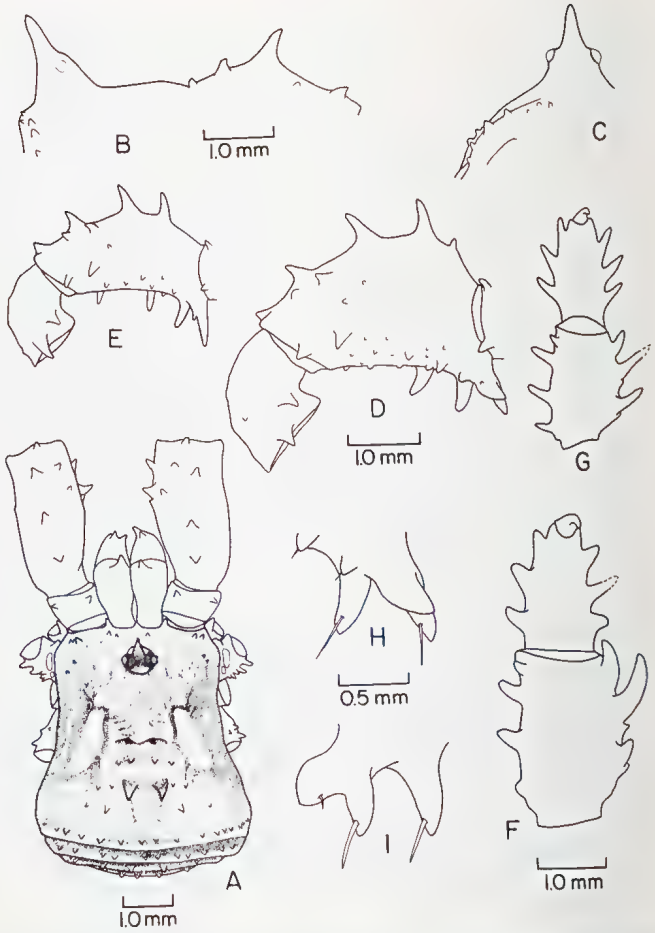

Fig. 10. *Equitius montanus* n.sp.; male: A–D,F,H–I; female: E,G. **A**, dorsum showing body colour pattern; **B**, lateral profile of scute; **C**, anterior profile of eyemound; **D – E**, prolateral view of pedipalp tibia and tarsus; **F – G**, ventral view of pedipalp tibia and tarsus; **H – I**, proximoventral trifid spine on pedipalp femur: H, prolateral; I, posterior.

thickness to length 0.51–0.56. Femur with 4 mediodorsal spines and 2–3 spines placed more prolaterally (Fig. 9A,D). Shape of proximoventral trifid spine as in Fig. 9D,H,I: proximal process strongly developed, more or less parallel to main axis when viewed laterally, reaching beyond base of relatively strong distal process. On prolateral surface, tips of 2 distal spines not reaching level of ventral surface when viewed laterally (Fig. 9D).

Legs (Fig. 13F): proportion leg 4 femur to scute length 0.76–0.93. Tarsal formula: 4–5, 11–15, 4, 4. Form of metatarsal notch as in Fig. 13F.

Penis (Fig. 4D–F): shape of fused ventral plates and arrangement of setae as in Fig. 4D,E; both subject to minor variation. Dorsal plate (Fig. 4F) apically bifid, very short (not reaching level of superior setae) and much narrower than base of glans. Lateral plates long, reaching level of superior setae (Fig. 4E).

FEMALE. *Measurements* (mm) paratype KS 6485: scute length 3.70, width 3.42; carapace length 1.61, width 2.42; genital operculum length 0.53, width 0.60; chelicera length, first segment 1.19, second 1.65, total 2.84.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.44	2.05	0.59	1.70	2.07	1.17	8.02
Leg 2	0.59	3.11	0.87	2.86	3.48	3.04	13.95
Leg 3	0.44	2.45	0.59	2.01	2.67	1.65	9.81
Leg 4	0.44	3.20	0.70	2.56	4.00	2.09	12.99
Pedipalp	0.37	1.90	1.20	1.20	–	1.25	5.92

Differs from male as does that of *E. doriae*. Tarsal formula: 3, 10–12, 4, 4.

Variations. Scute length ranges from 3.60–4.53 mm. The lateral spine on the scute above coxa 3 is small in populations in the Jeogla area at the south-western extent of the known range of *E. richardsae*.

Distribution. Along the coastal strip of N.S.W. from north side of Hastings River Valley to south side of Clarence River Valley. Along the ranges, its approximate western limits extend from the Jeogla area in the south (but not Point Lookout area), to Dorrigo Plateau, Gibraltar Range National Park, and northward to Bald Mountain on the Great Dividing Range in the extreme south of Queensland. The eastern-most record at this latitude is Mt Lindesay via Woodenbong.

Comments. Both *E. richardsae* and *E. tambourineus* show unusual development of spines along the lateral margin of the carapace above coxae 2 and 3 respectively. The structure of the pedipalp in *E. richardsae* is remarkably similar to that of *E. doriae*, but the femur of the latter tends to have 5 mediodorsal spines rather than 4. Apart from these possibly independently evolved similarities, *E. richardsae* has a highly distinctive penis possessing a short and apically bifid dorsal plate and relatively long lateral plates which distinguish it from other species.

Equitius montanus n.sp.
Figs 4G-I;10;11;13G-H;14D

Type material. HOLOTYPE ♂ Point Lookout, New England National Park, N.S.W., temperate rainforest, 28 August 69, G.S. Hunt, AM KS6495.

PARATYPES: New South Wales: Point Lookout, temperate rainforest, 28 August 69, G.S Hunt, ♀, AM KS6496; Round Mountain, New England National Park, wet sclerophyll forest, 28 August 69, G.S. Hunt, 3 ♂, 2 ♀, AM KS6498; same data, 1 ♂, 1 ♀, ANIC; Point Lookout, snow-gum woodland, 28 August 69, G.S. Hunt, 1 ♂, 1 ♀, AM KS6497; Point Lookout, 17 July 65, B. Cantrell, 1 ♂, 1 ♀, UQ; 26 km W. of Dorrigo on Ebor Rd, subtropical rainforest, 30 August 69, G.S. Hunt, ♂, 2 ♀, AM KS6499.

Description. The following description is based on the '4-spine' form, with differences exhibited by the '5-spine' form discussed under 'Variations'.

MALE. As in *E. doriae* except as set out below.

Measurements (mm) holotype: scute length 4.72, width 4.40; carapace length 2.45, width 3.39; genital operculum length 0.81, width 0.73; chelicera length, first segment 1.52, second 2.50, total 4.02.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.59	2.93	0.76	2.34	2.75	1.72	11.09
Leg 2	0.74	4.15	1.21	3.59	4.38	3.70	17.77
Leg 3	0.63	3.30	0.66	2.64	3.20	2.12	12.55
Leg 4	0.70	4.00	1.05	3.39	4.78	2.71	16.63
Pedipalp	0.52	3.20	2.02	1.95	-	1.94	9.63

Ranges (mm): length scute 4.05–5.13, length leg 4 femur 3.94–4.34, length pedipalp femur 2.71–3.66.

Colour: pattern as in Fig. 10A. Scute orange-brown with dark-brown to black pigmented areas. Chelicerae and pedipalps orange with dark-brown reticulations. Legs yellowish-brown with darker brown markings.

Body (Fig.10A–C): large; eyemound spine long and relatively stout, eye-level *c.* 0.38 total eyemound height. Tubercles along anterior margin of carapace small (Fig. 10B,C).

Chelicerae: very long; proportion second segment to scute length *c.* 0.53.

Pedipalps (Fig. 10A,D,F,H,I): very long and robust; proportion femur to scute length 0.67–0.72; proportion femur dorsoventral thickness to length 0.55–0.64. Dorsal surface of femur rising steeply from articulation with trochanter and with only 1–2 spines placed more prolaterally to 4 mediodorsal spines (Fig. 10A,D). Shape of proximoventral trifid spine as in Fig. 10D,H,I; proximal process directed backwards and curved across main axis when viewed laterally (Fig. 10H), distal process small or absent. Midventral spine slightly smaller than more proximal retroventral spine. Tips of 2 distal spines on prolateral surface not reaching level of ventral surface when viewed laterally. The equivalent of the most distal medioventral spine in *E. doriae* reduced to small tubercle. Distal prolateral spine on tibia, and spine proximal to it, both extremely strong and strongly curved towards tarsus (Fig. 10F). Smaller proximal prolateral spine also curves towards tarsus.

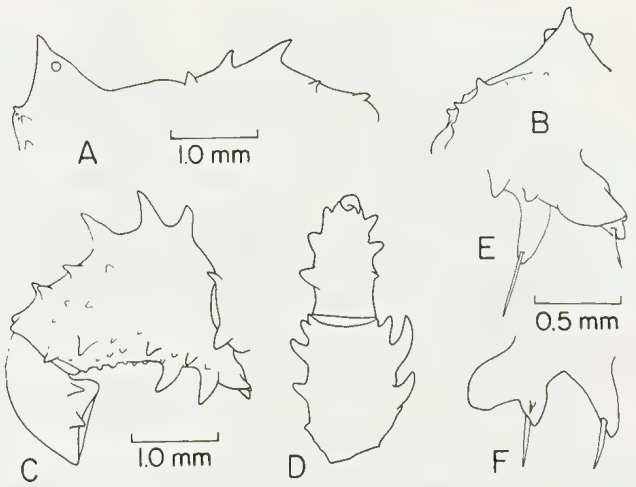

Fig. 11. *Equitius montanus* n.sp.; '5-spine form', male. **A**, lateral profile of scute; **B**, anterior profile of eyemound; **C**, prolateral view of pedipalp femur; **D**, ventral view of pedipalp tibia and tarsus; **E – F**, proximoventral trifid spine on pedipalp femur: E, prolateral; F, posterior.

Legs: proportion leg 4 femur length to scute length 0.84–0.97. Tubercles on retrolateral surface of coxa 2 and prolateral surface of coxa 4 as in Fig. 10A. Ventral notch on metatarsus very deep, proximal slope steep, prominent mound on proximal edge (Fig. 13G; 14D). Tarsal formula: 5-6, 11-15, 4, 4.

Penis (Fig. 4G–I): shape of fused ventral plates and arrangement of setae as in Fig. 4G,H, but subject to variation. Dorsal plate long, narrower than base of glans, reaching beyond level of base of superior setae. Lateral plates short. Glans wide basally, but narrow subapically; apex markedly spatulate.

FEMALE. *Measurements* (mm) paratype KS6496: scute length 4.36, width 4.70; carapace length 2.11, width 3.00; genital operculum length 0.70, width 0.79; chelicera length, first segment 1.30, second 2.12, total 3.42.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.52	2.45	0.70	2.10	2.42	1.43	9.62
Leg 2	0.63	3.63	1.00	3.22	3.85	2.93	15.26
Leg 3	0.57	2.89	0.66	2.42	3.00	1.50	11.04
Leg 4	0.66	3.55	0.87	3.11	4.38	2.34	14.91
Pedipalp	0.48	2.52	1.53	1.58	-	1.57	7.68

Differs from male in: trifid spine on femur with proximal process not directed backwards across main

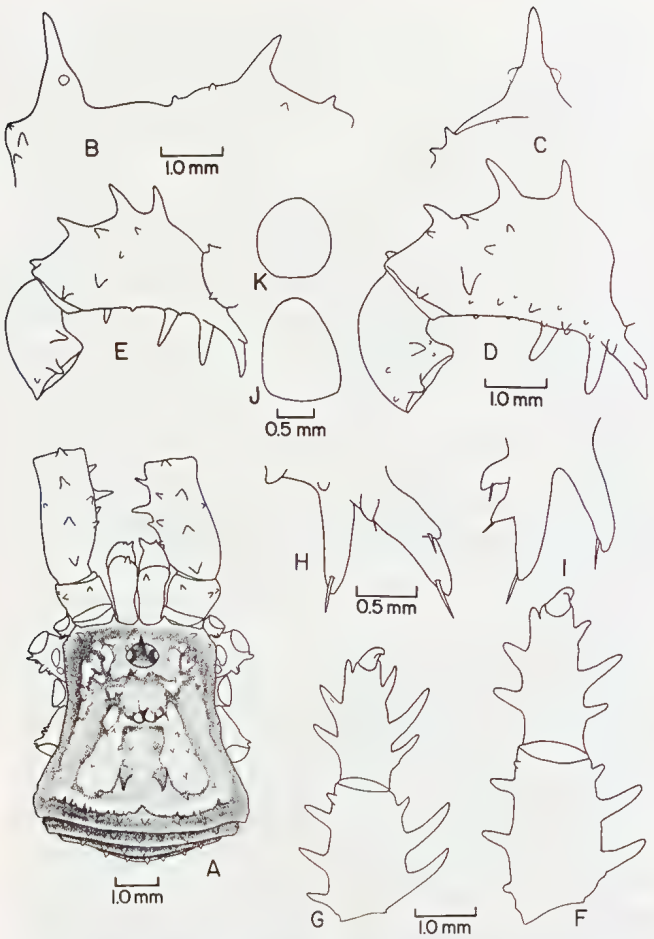

Fig. 12. *Equitius formidabilis* n.sp.; male: A–D,F,H–J; female: E,G,K. **A**, dorsum showing body colour pattern; **B**, lateral profile of scute; **C**, anterior profile of eyemound; **D – E**, prolateral view of pedipalp tibia and tarsus; **F – G**, ventral view of pedipalp tibia and tarsus; **H – I**, proximoventral trifid spine on pedipalp femur: H, prolateral; I, posterior; **J – K**, genital operculum, male and female.

axis of spine; prolateral spines on tibia not as strong and strongly curved (Fig. 10G); tarsal formula 3, 7–13, 4, 4.

Distribution. High country in the Point Lookout - Ebor area, N.S.W.

Variations. Several Form A specimens lack a distal process on the trifid spine of the pedipalp femur and, if present, it is small.

A possible case of ecophenotypic variation occurs in this species. Specimens collected in the temperate rainforest at Point Lookout, and the eucalypt forest on Round Mountain, have the same general form as that described above. Specimens from the small area of snow-gum woodland at the summit of Point Lookout (altitude 1,600 m) resemble the rainforest specimens in: penis structure; the presence of a strong, backwardly directed proximal process on the trifid spine of the pedipalp femur (Fig. 11E); the presence on the prolateral surface of the pedipalp tibia of strong spines which curve markedly towards the tarsus (Fig. 11D); the structure of the metatarsal notch (c.f. Fig. 13G,H). However, these 'snow-gum' specimens differ in that they are smaller in size (scute length 3.70–4.22 mm); have shorter pedipalps and legs relative to scute length (proportions 0.58–0.64 and 0.74–0.80 respectively); have a less steeply sloping eyemound with a shorter spine (Fig. 11A,B); have shorter spines on TA3 (Fig. 11A) and 5 instead of 4 spines along the dorsal surface of the pedipalp femur (Fig. 11C). Tarsal formula: 5, 9–13, 4, 4.

For convenience they are referred to as '5-spine' (snow-gum woodland) and '4-spine' forms; both have Form A and Form B males. A possible explanation is that less equable conditions of the woodland result in the general stunting of the '5-spine' form, due perhaps to nutrition or to an effect of temperature on development. However, the presence of 5 spines instead of 4 is difficult to explain in these terms.

Another possibility is that they are different species. Although the rainforest gives way abruptly to the woodland with virtually no ecotone, there appears to be little mixing between the two populations. From a large series, only one specimen of the '4-spine' form (a female) was taken in the woodland, and no individuals of the '5-spine' form were taken in the rainforest. If the study of vagility in *E. doriae* is a guide (Hunt, 1979), more mixing of these two populations might have been expected. It is therefore possible the two forms are different, but closely related species, with distinct habitat preferences. In the absence of further data the ecophenotypic explanation is tentatively accepted.

Comments. This species most closely resembles *E. spinatus* from which it has probably evolved. It differs from it in the presence in the penis of a relatively attenuated dorsal plate lacking a narrow apical process, and in specialised modifications of the trifid spine on the pedipalp femur and the prolateral spines on the pedipalp tibia. The morphology of these last two characters also distinguishes *E. montanus* from all other species.

E. montanus has been recorded at altitudes above 1,100 m from rainforest, eucalypt forest and woodland in the New England National Park area, but may have a wider distribution especially to the north. It is sympatric with *E. richardsae*, which generally occurs at lower altitudes, in a small patch of rainforest between Dorrigo and Ebor.

Equitius formidabilis, n.sp.

Figs 4J–L;12;13I;14E

Type material. HOLOTYPE ♂: Bryants Creek, Royal National Park, 9 July 70, M.R. Gray, AM KS6491.

PARATYPES: New South Wales: Bryants Creek, Royal National Park, 9 July 70, M.R. Gray, 2 ♂, AM KS6492; Jamberoo Mtn, via Kiama, 5 April 70, G.S. Hunt, 1 ♂, 2 ♀, AM KS6491, KS6493; Mt Kiera Faunal Reserve, 25 January 78, M.R. Gray & C. Horseman, AM KS1500; Cambawarra Mtn, via Bomaderry, 19 December 80, G.S. Hunt, 1 ♂, 1 ♀, ANIC.

Description. MALE. As in *E. doriae* except as set out below.

Measurements (mm) holotype: scute length 5.36, width 5.30; carapace length 2.53, width 3.85; genital operculum length 1.24, width 0.96; chelicera length, first segment 1.98, second 2.75, total 4.73.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.61	3.85	0.91	3.11	3.74	1.87	14.09
Leg 2	0.95	5.88	1.36	5.21	6.64	4.26	24.30
Leg 3	0.87	4.64	0.98	3.40	4.90	2.38	17.14
Leg 4	0.91	5.94	1.46	4.45	7.44	2.93	23.13
Pedipalp	0.70	3.74	2.36	2.38	–	2.38	11.56

Ranges (mm): length scute 4.64–5.36, length leg 4 femur 5.32–5.94, length pedipalp femur 3.08–3.74.

Colour: pattern of dorsum as in Fig. 12A. Overall colour of scute orange-brown with lighter patches of yellowish-brown but heavily pigmented areas are dark-brown to black. Chelicerae and pedipalps orange-brown with dark-brown reticulations. Background colour of legs yellowish, but mainly obscured by dark-brown to black pigmentation.

Body (Fig. 12A–C): very large; eyemound rising slightly further behind anterior margin than in other species of *Equitius* and with very long, suberect spine (Fig. 12B). Viewed laterally, eyemound narrow with posterior edge sloping steeply, eye-level *c.* 0.3 total eyemound height. Viewed anteriorly, lateral edge of eyemound slopes steeply immediately below eyes (Fig. 12C). Anterior margin with 1–2 small spines above each pedipalp coxa (Fig. 12A–C). Mesial pair of spines on TA3 very large, pairs on TA1 and TA2 very small and of equal size. Spines forming rows on TA5 and free tergites relatively large. Genital operculum very large and relatively long (Fig. 12J).

Chelicerae: long; proportion second segment length to scute length 0.51.

Pedipalps (Fig. 12A,D,F,H,I): very long; proportion femur to scute length 0.62–0.70. Proportion femur dorsoventral thickness to length 0.50–0.56. Femur with 4 mediodorsal spines with 2–3 much smaller spines placed more prolaterally (Fig. 12A,D). Shape of proximoventral trifid spine as in Fig. 12D,H,I; proximal process very weak, little stronger than distal process. Viewed posteriorly (Fig. 12I) proximal process and main axis not V-shaped or arcuate. Midventral spine smaller than more proximal retroventral spine; spines on proventral margin immediately distal to trifid spine small (Fig. 12D). Tips of 2 distal spines on prolateral surface failing to reach level of ventral surface when viewed laterally (Fig. 12D). Long spines on lateral margins, especially prolateral margin of tibia and tarsus. Spine on retrodistal corner of tibia longer than that on prodistal corner. Second spine on prolateral margin of tarsus much longer than other spines. Tarsus relatively slender, longer than broad in ratio 1.2:1.

Legs: extremely long; proportion leg 4 femur to scute length *c.* 1.11. Ventral notch on calcaneus of leg 1 very shallow, lacking prominent mound on proximal edge (Fig. 13I); distal part of nodule field interrupted by transverse grooves (Fig. 14E). Tarsal formula: 4–5, 12–15, 4, 4.

Penis (Fig. 4J–L): ventral plates extremely long, twice as long as wide. Dorsal plate long but not reaching level of superior setae on ventral plate, narrower than base of glans and tapering to a blunt point. Lateral plate long, slender, tonguelike. Glans very broad basally, lateral margins following margins of ventral plates; viewed laterally glans markedly curved.

FEMALE. *Measurements*(mm) paratype KS6493: scute length 4.98, width 5.55; carapace length 2.20, width 3.46; genital operculum length 0.95, width 0.98; chelicera length, first segment 1.72, second 2.25, total 3.97.

	Troch.	Fem.	Pat.	Tib.	Met.	Tar.	Total
Leg 1	0.63	3.19	0.86	2.71	3.15	1.50	12.04
Leg 2	0.76	4.90	1.21	4.53	5.51	3.68	20.59
Leg 3	0.62	3.85	0.76	3.11	4.15	2.12	14.61
Leg 4	0.86	5.02	0.98	4.00	6.30	2.71	19.87
Pedipalp	0.59	3.08	1.91	1.96	–	1.96	9.50

Very similar to male, but differs in having an approximately circular genital operculum (Fig. 12K); having a weaker trifid spine including proximal process on the pedipalp femur (Fig. 12D); having relatively longer retroproximal and pro- and retrodistal spines on the pedipalp tibia (Fig. 12G). Tarsal formula: 3, 12–13, 4, 4.

Variations. Only 8 specimens were available for study and no important infraspecific variations were noted except that the shape of the genital operculum may vary slightly in the male, being more elongate in some individuals than in others. It is not known if male dimorphism occurs as no bimodality was detected in the small samples.

Distribution. N.S.W., in patches of subtropical rainforest in coastal areas south of Port Hacking and north of Shoalhaven River.

Comments. This species has no close affinity with any other species of *Equitius*. Its highly distinctive characters include the structure of the penis, the lack of development of the trifid spine on the pedipalp femur and the form of the notch on metatarsus 1.

Discussion

While the genus is an arbitrary category, there is little doubt that the seven species currently placed in *Equitius* constitute a phylogenetic unit. All possess a penis and male metatarsal notch with the same basic structure, and have fundamentally the same morphology in other respects, including spination of the eyemound, scute and pedipalp. This cannot be said for certain other Australian harvestmen genera, such as *Nunciella* Roewer (Hunt, 1971), which contain a miscellany of species of doubtful affinity. Thus the previous confusion regarding the taxonomy of species of *Equitius* is a little surprising. It is attributable to two main causes: failure to recognise the nature of sexual dimorphism and undue

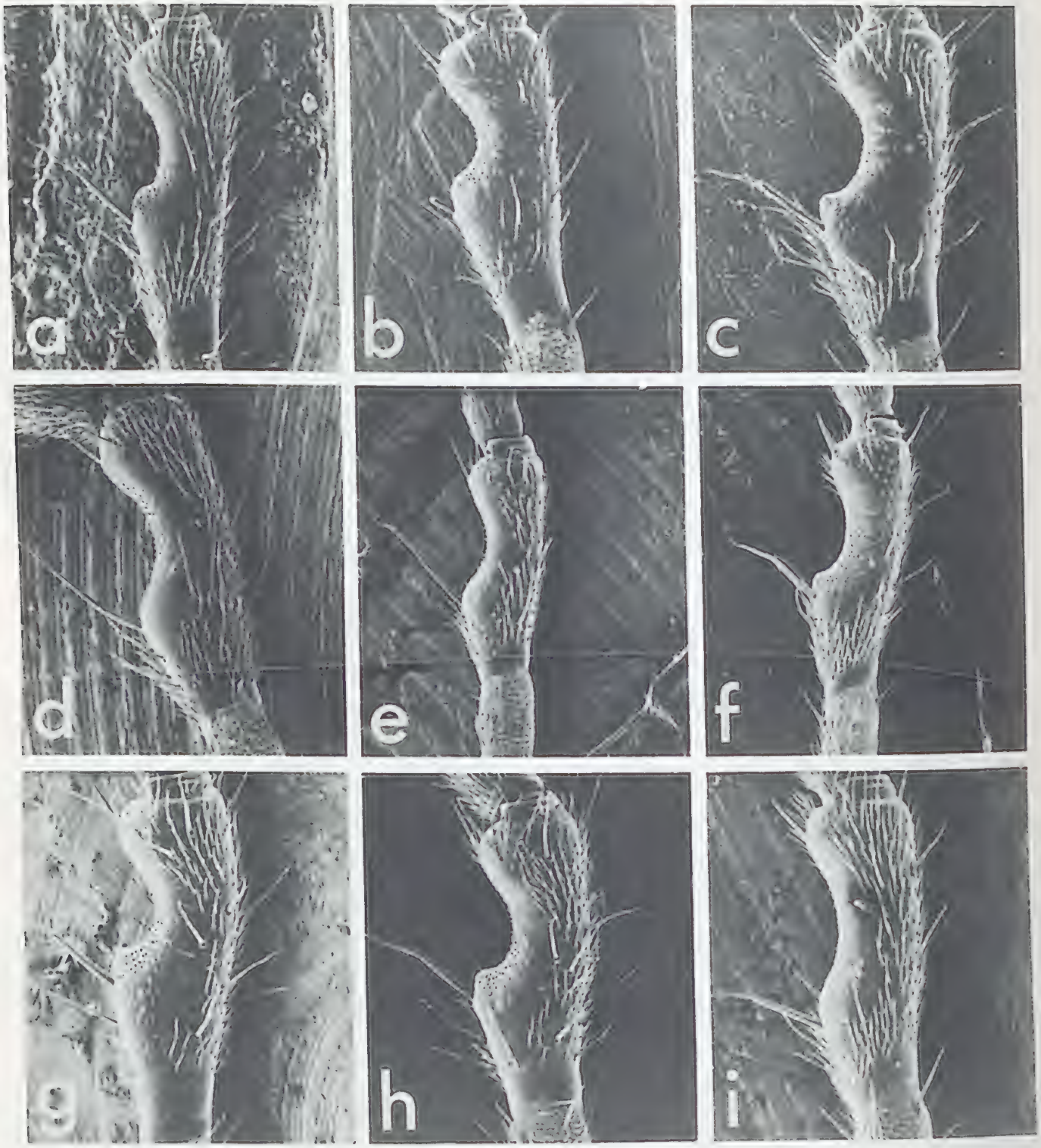

Fig. 13. Leg 1 metatarsal notch in male *Equitius* spp., prolateral. **a**, *E. doriae* Simon; **b**, *E. spinatus* (Pocock) ex Hillgrove; **c**, ex Barrington Tops population; **d**, *E. altus* (Forster); **e**, *E. tambourineus* (Roewer); **f**, *E. richardsae* n.sp.; **g**, *E. montanus* n.sp. '4-spine' form; **h**, '5-spine' form; **i**, *E. formidabilis* n.sp. Magnification: X 70.

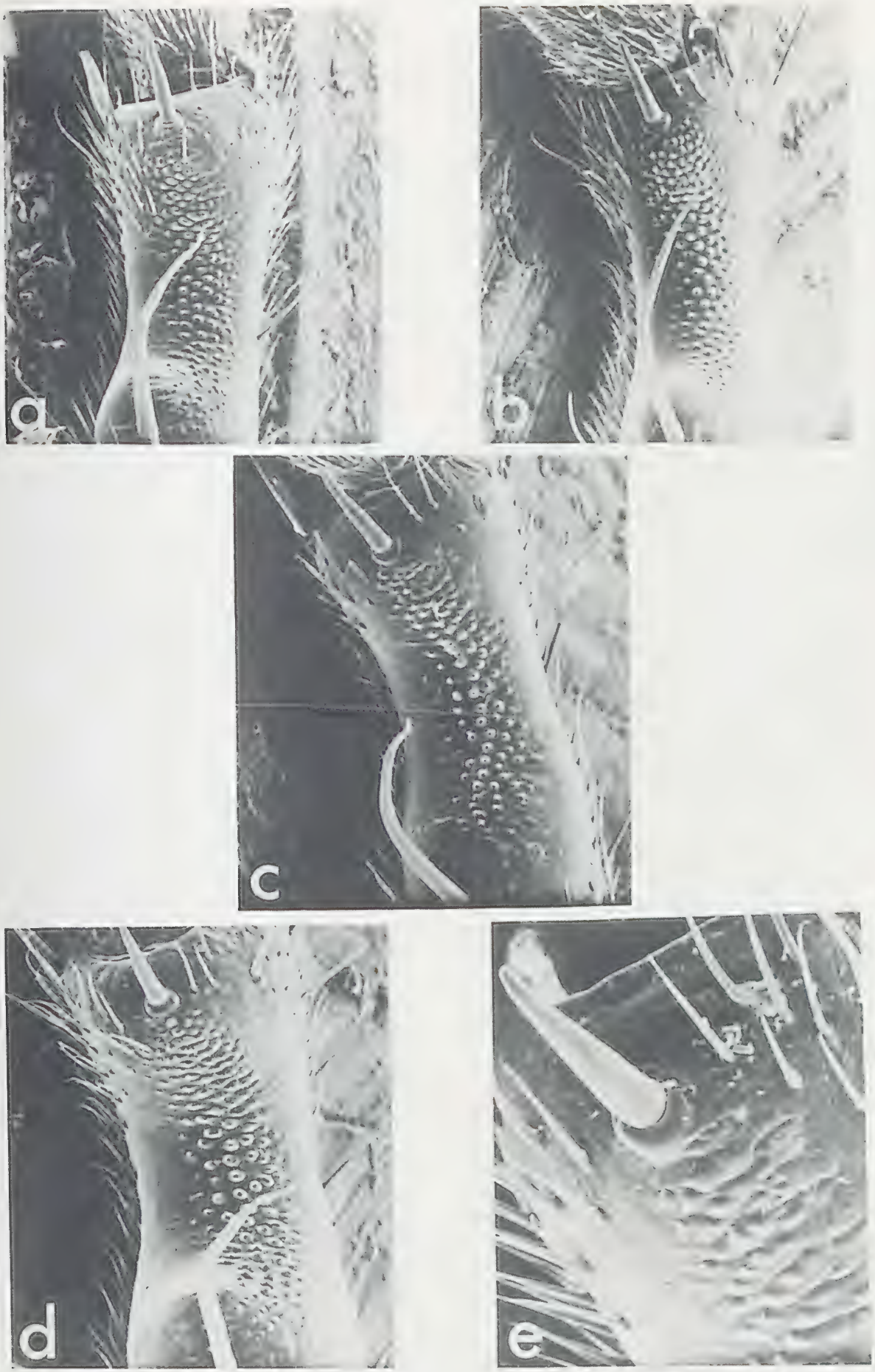

Fig. 14. Leg 1 metatarsal notch in male *Equitius* spp. ventral. **a**, *E. doriae* Simon; **b**, *E. altus* (Forster); **c**, *E. tambourinei* (Roewer); **d**, *E. montanus* n.sp.; **e**, *E. formidabilis* n.sp. distal region. Magnifications: a and b, X 160; c, X 240; d, X 180; e, X 310.

emphasis on the value of tarsal segmentation as a generic character.

Probably because of the relatively low frequency of Form B to Form A males, male dimorphism has not caused authors as much difficulty. However, Forster (1955), from his experience of male dimorphism in New Zealand harvestmen (Forster, 1954), believed he had identified this phenomenon in *E. altus* from Barrington Tops, N.S.W. As noted above, Forster's paratype 'Form B' male is, in fact, a Form A male of a separate species, *E. spinatus*, which is sympatric with *E. altus* at this locality. Also, Roewer (1931) misidentified a Form B male of *E. tambourineus* as a male of *E. doriae* while two Form A males were identified as females.

The seven species of *Equitius* are recognised on morphological grounds, and constitute morphospecies in the terminology of Mayr (1963; 1969). However, certain situations concerning *Equitius* permit direct evaluation of populations in terms of the biological species concept. At Barrington Tops, *E. altus* is sympatric with a population of *E. spinatus* while in the Carrai Bat Cave area, west of Kempsey, a cavernicolous population of *E. altus* occurs beneath a surface population of *E. spinatus*, ecological isolation being virtually complete. *Equitius richardsae* is sympatric with *E. montanus* in a small patch of rainforest between Ebor and Dorrigo. Further north, at Bald Mountain via Emu Vale in S.E. Queensland, *E. richardsae* is sympatric with *E. tambourineus*. Hybrids are not known in any of these examples of sympatry, although more sampling is required to determine the presence or absence of hybrid zones and the extent of range overlap.

In two of these examples the species involved show altitude preferences: at Barrington Tops and Point Lookout (near Ebor) which, interestingly, represent the areas of greatest topographic relief in N.S.W. outside the Snowy Mountains region. *Equitius altus* and *E. richardsae* are more common at low altitudes, whereas *E. spinatus* and *E. montanus* occur mainly at higher altitudes. *Equitius altus* and *E. spinatus* may also show habitat preferences, apart from the cave-surface example noted above. The former species occurs in both subtropical and temperate rainforst almost to the exclusion of the latter which, at Barrington Tops, is more common in *Eucalyptus* forest. Apart from having largely separate ranges, *E. richardsae* and *E. tambourineus* do not appear to have different altitude or habitat preferences.

The most closely related species in the genus appear to be *E. spinatus*, *E. montanus* and *E. doriae*. The affinities of the other four species are more obscure. The first two occur in adjacent parts of the New England Plateau but it is not known whether they are allopatric or partly sympatric.

Equitius spinatus and *E. doriae* seem to be geographically isolated, occurring respectively north and south of the Hunter River. Apart from the waterway itself, the main isolating barrier appears to be the topographic gap known as the Cassilis Gate (Taylor, 1919) which runs east-west through the Great Dividing Range. Being inland and low-lying, it has a lower rainfall than the mountain areas to the north and south, resulting in a zone of dry country unsuitable for *Equitius*. It is not known how long this has acted as a barrier to dispersal, but the morphological differences between the two species are not very marked. The discontinuous nature of moist montane areas has also been used to explain the distribution of flies in the genus *Pelecorhynchus* (Mackerras, 1942) and the geographical races of the phasmid *Didymuria violescens* (Leach) (Craddock, 1970). Lawrence (1953) believes discontinuous areas of moist habitat have promoted speciation in South African Triaenonychidae.

Both rivers and dry sclerophyll country appear to isolate *E. doriae* from *E. formidabilis*, though in this case the species are not closely related. The latter species occurs in patches of coastal rainforest from Royal National Park just south of Sydney to Cambawarra Mountain just north of the Shoalhaven River. Westwards, it appears to be isolated from populations of *E. doriae* by an inland tract of mostly dry sclerophyll country. Moister areas in this drier region are occupied by *Holonuncia* spp. *Equitius formidabilis* is the most distinctive species of the genus in both genital and external morphology, and has probably been isolated in rainforest areas south of Sydney for a considerable period. It may once have had a wider distribution when the rainforest belt was more continuous but, like *E. altus*, now appears to be restricted to isolated 'relict' populations.

The Hastings River Valley forms a barrier between populations of *E. spinatus* and *E. richardsae* occurring respectively to the south and north. Similarly, further north the Clarence River Valley separates populations of *E. richardsae* and *E. tambourineus*. While the Clarence River was once considered a major zoogeographical boundary between the southern, temperate Bassian fauna and the tropical Torresian fauna (Spencer, 1896; Littlejohn, 1967), it is not generally so recognised now (Horton, 1973) and is certainly not respected by *Equitius*.

The northern limits of *Equitius* appear to be in the vicinity of Brisbane and approximate the northern boundary of the modified Bassian distribution of Mackerras (1970). Northwards, *Equitius* is replaced mainly by tropical assamiids and phalangodids and also by species in the undescribed genus of triaenonychids (noted above), including the nominal species *Monoxyomma manicatum* and *M. rotundum*.

The low-lying area of drier country south of Goulburn known as the Lake George Gate (Taylor, 1919), and the Shoalhaven River in the moister coastal strip, appear to act as barriers to the southward dispersal of *Equitius*. To the south, *Equitius* is replaced principally by the related genus *Holonuncia*, and by *Nunciella* and the undescribed genus noted above.

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Globopilumnus multituberosus Garth & Kim, 1983 —A New Record for Australia (Decapoda: Crustacea: Menippidae)

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ABSTRACT. The menippid crab, *Globopilumnus multituberosus* Garth & Kim, 1983 is recorded from Australia for the first time, and considerably extends the known range of this deep water species. This is only the second species of the genus recorded from Australia, the first being *G. actumnoides* (A. Milne Edwards, 1873), recorded by Ward (1932).

NG K.L. PETER & LEO W.H. TAN, 1985. *Globopilumnus multituberosus* Garth & Kim, 1983 - a new record for Australia (Decapoda: Crustacea: Menippidae). Records of the Australian Museum 36: 127-129.
Keywords: Decapoda, Menippidae, taxonomy, Australia.

In a recent study on some Indo-Pacific pilumnid crabs (Superfamily Xanthoidea McLeay, 1838 *sensu* Guinot (1978) (Ng 1983), the authors had the opportunity to examine some material from the Australian Museum, through the kind courtesy of Drs D.J.G. Griffin and James Lowry. Of these, one was a specimen collected from Victoria, Australia and had been identified by Mary Rathbun (1923, pg. 111) as '*Pilumnus spongiosus* Nobili, 1905'. Balss (1933), in his review of the Indo-Pacific pilumnids, transferred this species to his new genus *Planopilumnus*, and remarked that Rathbun's specimen may have been a juvenile. A careful examination of the specimen, however, showed that Rathbun had misidentified the animal, which should instead be referred to *Globopilumnus multituberosus* Garth & Kim, 1983, a species recently described from the Philippines. The present specimen thus represents a new record for Australia. Until now, the only species recorded from Australia is *Globopilumnus actumnoides* (A. Milne Edwards, 1873), which is found in shallow waters in North West Australia (Ward 1932). The genus *Globopilumnus* Balss, 1933 is characterised by having a hairy carapace, whip-like male pleopod 2 and stout, straight male pleopod 1. It is tropical in distribution and contains eight species, of which five are found in the Indo-Pacific: *G. globosus* (Dana, 1852), *G. actumnoides* (A. Milne Edwards, 1873), *G. calmani* Balss, 1933, *G. multituberosus* Garth & Kim, 1983 and *G. kiiensis* Takeda & Nagai, 1983.

Genus Globopilumnus Balss, 1933
Globopilumnus multituberosus Garth & Kim, 1983

Fig. 1

Pilumnus spongiosus Rathbun, 1923: 111
Planopilumnus spongiosus Balss, 1933: 40
Globopilumnus multituberosus Garth & Kim, 1983: 689, fig. 6 (not *Pilumnus spongiosus* Nobili, 1905)

Material examined. 1♂ (Australian Museum: E6212) (7.1 by 5.6mm), coll. by F.I.S. 'Endeavour' south of Gabo Island, Victoria, Australia from 200 fathoms, det. as *Pilumnus spongiosus* Nobili, 1905 by M.J. Rathbun in 1923.

Remarks. This species was described from specimens collected from the Philippine Islands and off Honshu Island, Japan. It is characteristic in having the teeth on the anterolateral margin covered with small granules, especially at or near the tip, and can easily be separated from *G. actumnoides* by means of this character.

The present record thus greatly extends the known range of this species. The types were collected from depths ranging from 140 to 338 fathoms, the present specimen from 200 fathoms. *Globopilumnus multituberosus* also appears to be the deepest dwelling of all the known species in the genus; the others being shallow water species.

The present specimen agrees well with the original descriptions by Garth and Kim in 1983, but differs in having the supraorbital margin smoother, with two well developed teeth (not two tubercle covered lobes)

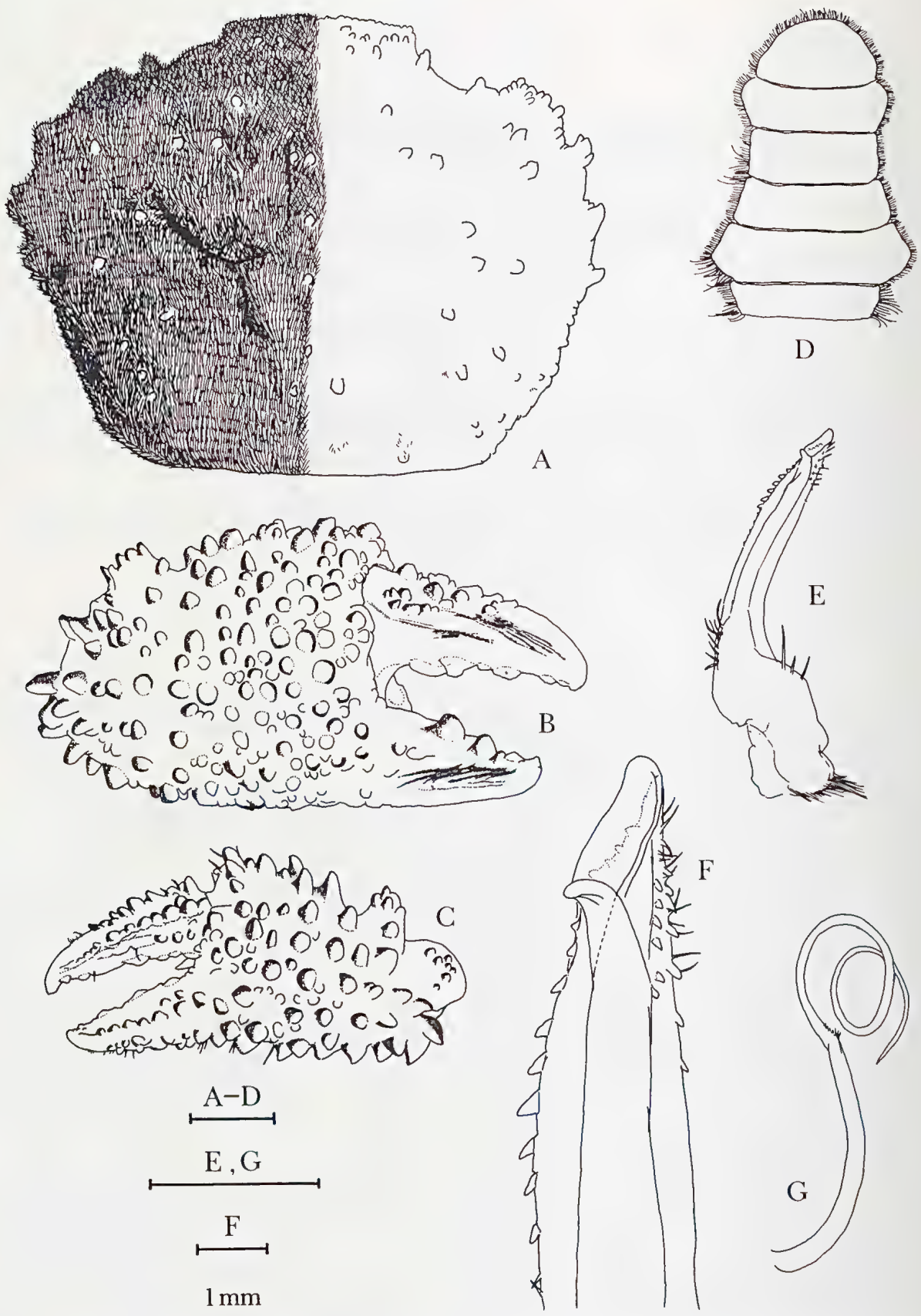

Fig. 1 *Globopilumnus multituberosus* Garth & Kim, 1983. **A**, dorsal view of carapace (right side denuded); **B**, right cheliped; **C**, left cheliped; **D**, abdomen; **E**, **F** male pleopod 1; **G**, male pleopod 2.

(Fig. 1A). The tubercles on the outer surfaces of the chelipeds are more worn and the cutting teeth of the fingers are sharper (Fig. 1B,C).

The chelipeds are asymmetrical, the right one being larger. The abdomen is broad with the last segment rounded (Fig. 1D). The male pleopod 1 is similar to those of the other four species of *Globopilumnus* so far recorded from the Indo-Pacific (see Guinot-Dumortier 1960 and Takeda & Nagai 1983), with the tip slightly 'flared' (Fig. 1E,F). The distal regions are covered with numerous short, strong spines. The straight, stout male pleopod 1 and the whip-like male pleopod 2, with its long flagellum (Fig. 1G), are typical for crabs of the family Menippidae Ortmann, 1893 *sensu* Guinot 1978, Superfamily Xanthoidea.

Like *G. globosus*, *G. actumnoides* and *G. kiiensis*, *G. multituberosus* does not have any stridulatory organs on the chelipeds and ambulatory legs. Such organs are however found in the Indo-Pacific *G. calmani*, the West African *G. africanus* (A. Milne-Edwards, 1867) and *G. stridulans* Monod, 1956 (Guinot-Dumortier & Dumortier 1960), and the North American *G. xantusii* (Stimpson, 1860) (Garth, 1968).

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Australian Flaked Stone Tools: A Technological Perspective

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Abstract. Australian flaked stone technologies are examined from a flintknapper's perspective. We identify six different flaking techniques in the archaeological collections, but only a single reduction sequence. The five stages of this sequence are described in detail and it is demonstrated that Australian technologies are highly opportunistic. We examine major classes of Australian flaked stone artefacts — adzes, backed artefacts, burins, points, 'scrapers', 'utilized flakes' — from a technological perspective. We conclude that most morphological variation within these broad classes is not the result of deliberate design. We also note that 'backing' is simply the application of already-known bipolar technology to small flakes, and that more precise use-wear studies are needed to determine that 'scrapers' and 'utilized flakes' were actually used as tools.

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Stone tool manufacture has been established for at least 2.5 million years. In this period, flintknappers have transformed stones into tools by literally thousands of different techniques. Technological sophistication, necessity, and time and energy expended to make these different stone tools have varied considerably throughout prehistory, with every technology having in common the basic necessity of producing functional tools.

In this paper we argue that within Australia and Tasmania all the tool type preforms used throughout the last 40,000 years were produced from a single reduction sequence. Lithic raw materials were selected and reduced, solely by percussion techniques, into a variety of flakes and blades which served as preforms for formal as well as informal tool types. Heat treatment was frequently employed at different stages of reduction to improve the flaking qualities of the raw materials (Flenniken & White, 1983). The technologies used in Australia were thus ingeniously simple and flexible. They were also highly opportunistic, and exploited the potential of the reduction sequence in a variety of ways.

In the sections which follow we present Australian flaked stone technologies as a single sequence, for the sake of clarity and continuity. We stress that this sequence was rarely produced prehistorically as a single event from a single piece of stone. Our account is based on JJF's flintknapping experience, replicative experiments, intensive inspection of museum collections and material from a number of archaeological sites, discussions with various colleagues, and the literature.[1] It is important to note that this paper is primarily JJF's technological view of the Australian flaked stone material and we do not attempt any detailed comparison with ethnographic or archaeological assemblages from particular sites. As far as we are aware, no studies based on a detailed understanding of knapping technology have been made of Australian assemblages, although such are now in progress (e.g. by D. Witter, P. Hiscock and R. Fullagar). These are clearly necessary to test and develop the interpretation given here.

We start by defining the concepts of technique, sequence and technology (cf. Crabtree, 1972; Flenniken, 1981). A technology is the total sum of flintknapping knowledge possessed by a group of knappers and demonstrable from the end-products of their knapping behaviour. Each technology is composed of a number of particular techniques, which are specific methods by which flakes are removed from a stone to achieve a particular goal. The techniques, and the sequence in which those techniques are applied to the stone, form an identifiable cultural pattern. This

pattern is visible in the prehistoric record in the stone material remains at knapping locations. It should be noted that technologies are defined by both technique and sequence, so that if, for example, the same techniques were used at two sites, but the sequence in which those techniques were applied to the stone differs, then we are observing two different technologies. Within Australia, the situation is that the same sequence has been used throughout prehistory, but six different techniques have been employed in a variety of orders. Thus there are a number of areally and temporally specific prehistoric technologies. We do not attempt to define these here. We note that the technology used at any site is deduced from the material record: what the manufacturers 'had in mind' is neither detectable nor relevant (cf. White, Modjeska & Hipuya, 1977).

The basic Australian reduction sequence is given in Figs 1 and 2. All stages of this sequence can sometimes be found in a single prehistoric record, but this is not always the case. The sequence remained the same, but stages in it were often intentionally by-passed depending on the numbers of specific tool types required (e.g. backed blades, adzes) and the shape and geological type of raw material. In other words, if only macro-flakes were required for specific tool types, then a selected core was totally reduced within stage II, or, if only poor quality flaking raw material was available, then the reduction sequence may have been limited by it to stage II only. The fact remains, however, that all of the stone tool preforms were produced from a single reduction sequence. A series of different reduction sequences has not been seen in Australian or Tasmanian materials, and we suspect the same is true for New Guinea. We note that this situation is unusual in world terms. In north America, for example, many different reduction sequences were used, over time, even within a very small area such as a single stream valley. A similar pattern is widespread throughout the Old World.

Within Australia, artefact manufacture from flake or blade preforms most frequently employed the two reduction techniques of free-hand percussion and bipolar. Four other techniques—percussion bifacial thinning, percussion 'backing', burination and pressure flaking—were also used at various times, the latter two probably only during the last few thousand years. All of these techniques employ the same basic knapping principles. None of them imply drastic technical changes such as might be introduced from some external source; all are developments of a single reduction sequence.

We suggest that to find only a single reduction sequence, a limited number of techniques and thus a highly opportunistic use of stone in Australia is congruent with our other information about stone tools. It has been known for a long time that formal patterning of stone tools was relatively uncommon in the prehistoric record (e.g. Mulvaney & Joyce, 1965) and that this is also the situation in other parts of the southwest Pacific (White, 1977). Ethnographic observations in both Australia (Hayden, 1979; Wright, 1977) and New Guinea (White, 1968a; White & Thomas, 1972) have shown that most stone tools were completely opportunistic, being pieces of stone selected for their intended task, rather than designed and made to a regular formal pattern.

What can now be demonstrated is that all formally patterned stone tools can easily be produced from a single reduction sequence, i.e. Australian knappers worked within a framework of the minimum possible complexity. We will demonstrate further that in the production of formal tools, Australian knappers were also often opportunistic, that is, they would frequently only employ the minimum amount of flaking required to make a particular shape. Thus, for example, many backed artefacts, which were already small, appropriately shaped flakes, were only backed along part of one side.

The Australian Reduction Sequence

Stage I: Selection of Raw Materials. All lithic materials that were selected for the production of flaked stone tools must fracture conchoidally to some degree. A conchoidal fracture ensured the prehistoric knapper of a predictable end result whether it was a flake in the manufacturing process or the intended end product such as a tula adze. Conchoidally fracturing

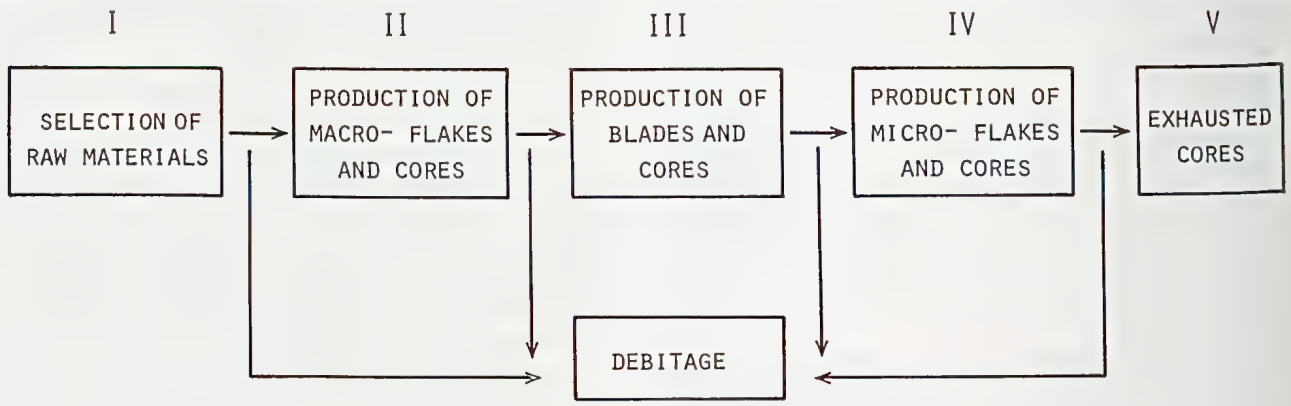

Fig. 1. Australian flaked stone tool reduction sequence.

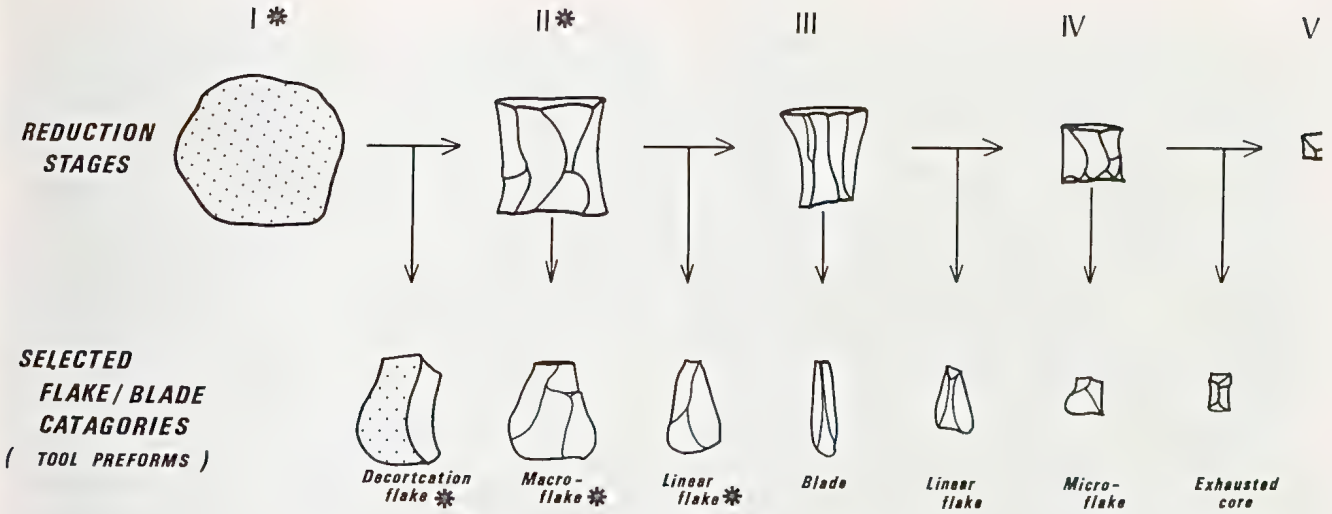

Fig. 2. Australian reduction sequence and selected flaked tool preforms.
* indicates heat treatment locations during the sequence.

materials selected by Australian knappers included chert, chalcedony, jasper, silcrete, quartzite, basalt, silicified wood and other igneous and metamorphic rocks.

Flakeable lithic materials occurred naturally in a variety of sizes and shapes. Both size and shape played an important role in both transportation and reduction sequences. Transportable materials occurred in three sedimentological sizes: pebbles < 64 mm, cobbles 64–256 mm and boulders > 256 mm. Within this size range, large cobbles and small boulders were frequently too heavy or awkward to transport and were therefore partially reduced where they were found. Some initial reduction was often also conducted to test the quality of each piece of stone. Thus primary reduction of material from any source may have been an economising measure rather than one designed with particular end-products in mind. This is consistent with the observations of, for example, Love (1936:74) and Byrne (1980).

Raw materials occurred naturally in four basic shapes: rounded, sub-rounded, sub-angular and angular. The specific shape of a rock may be the result of its primary geological deposition or of processes acting on it later. For example, if angular materials are transported long distances by water, they will be secondarily deposited as rounded or sub-rounded rocks depending upon distance travelled; the longer the distance, the more rounded the material.

The natural shape of material was important from a technological perspective. Material shape often dictated the primary stage of the reduction process. For example, if a material occurred in tabular (angular) pieces, the first stage of reduction would be alternate flaking which started at a corner and established each flake platform by the previous flake scar (cf. Basedow, 1925:368). If the selected raw material was a medium sized, rounded pebble, then bipolar was the most frequent method of primary reduction due to the physical limits of the stone. We note that even if material did dictate the primary reduction stage, a culturally patterned reduction sequence may be employed subsequently.

Flakeable lithic materials possess two types of cortex or weathered exterior. The cortex type will identify the geological environment from which the material was quarried or collected prehistorically. Primary geological cortex occurs on materials that were procured from the same geological environment in which they were produced. Incipient cone cortex, on the other hand, is created by hundreds of small intersecting conchoidal fractures that can only result from water transportation. Therefore, materials with this kind of cortex were collected from a secondary deposit such as a river point bar or a beach.

Stage II: Production of Macro-flakes and Cores. Once the selected raw material was ready for reduction into useable flakes, either a natural platform was established at some location on the potential core, or a flaked platform was established by a percussion technique. If the material was angular or sub-angular in shape, then a natural, thin cortical surface, providing an angle of 90° or less to the potential working face of the core, was usually selected as the platform. Platform-to-working-face angles of greater than 90° created technical problems for the knapper on any type of core because more obtuse angles caused the flakes or blades to terminate abruptly in a hinge or reverse hinge (Fig. 3).

If the potential core was more rounded in shape, a flaked or faceted platform was prepared by one of four percussion techniques:

(i) If the selected material was large and rounded to sub-rounded, the potential core was placed on a stone anvil and struck with a hammerstone (on-anvil or block-on-block technique) (Gould, 1980:123). This sheared the core, providing a flat, single faceted platform at one end or through the middle of the cobble (Fig. 4).

(ii) An alternative technique for single facet platform preparation on large rounded to sub-rounded

material was simply throwing the potential core onto a stationary rock in the ground, then selecting suitable fragments as cores. This has been observed by JPW, in the eastern highlands of New Guinea in 1964.

(ii) A bipolar technique was frequently employed to fracture a small pebble or cobble in order to obtain a platform, or to get access into the stone for further reduction by a bipolar technique.[2] Small rocks were extremely difficult to fracture by direct free-hand percussion because it was difficult to support the small mass by hand (see Hiscock, 1982:39–41). Some bipolar techniques used in Australia and New Guinea are described by White (1968b). See Fig. 5.

(iv) The platform of a potential core of angular or sub-angular material could be prepared by direct free-hand percussion at a favourable location. A favourable location was one where acute angles occurred naturally between the potential core platform and the working-face of the core. This technique was usually employed in preference to (i) above when the cortex was thick and too much force dissipated within it or when, given the shape of the rock, a suitable platform did not naturally occur. Therefore, the cortex or an irregular surface was removed and a multifaceted platform was established directly in the fresh, cortex-free material (cf. Gould, Koster & Sontz, 1971:161; Gould, 1980:125–6).

Frequently, platform preparation and flake or blade removal occurred alternately throughout the entire reduction sequence due to raw material shape. Once a core platform was flaked or faceted, usually as a result of angular material shape, it had to be flaked after each series of flake or blade removals because the acute platform-to-working-face angle changed adversely as a result of the flake or blade removal (Figs 3 and 6). Platform preparation flakes usually exhibit a wide (margin to margin), faceted and laterally curved (margin to margin) platform with a pronounced bulb of force covering the majority of the ventral flake surface. The flakes usually terminate in a slight hinge or feather.

Another kind of faceted platform core is the bifacial core commonly found in Australia. With this, each bifacial core platform was created as a result of flake or blade removal. This bifacial process of flake or blade removal was usually dependent upon material shape (sub-rounded to rounded) and intended end product, and was an extremely efficient use of the raw material (Fig. 7).

The actual choice of the specific platform production technique was more a function of the size, shape and petrology of the selected raw material and was not necessarily a 'cultural' decision. All four core platform preparation techniques were known and used in prehistoric Australia. This fact illustrates the opportunistic and economising nature of Australian reduction technologies.

The first series of flakes produced from the macro-flake core were decortication flakes or flakes whose dorsal surface were wholly or partially covered by cortex. These flakes were employed as tools or blanks for tools if they met the technical and functional requirements of the user. The selection of decortication flakes as tools or tool blanks was dependent upon availability of material, flake size, shape and the presence of at least one useable edge.

Once the core was established, more regular flakes, in terms of size and shape, could be produced. Specific ones were then selected for the production of tools, or were edge-modified by percussion or pressure flaking into flake tools. The remainder of the flakes were either used as unmodified flake tools or discarded as debitage.

Selection of flakes for the production of tools was based upon a formal set of attributes. However, the limitations put on this attribute set varied directly with the availability of 'good' raw materials. In other words, the 'formality' of a morphological type was conditioned by functional necessity: the poorer the quality of raw material, the wider the range of formal attributes within any class of tools.

It should be noted that very large macro-flakes were also employed prehistorically as cores (Fig. 8). The

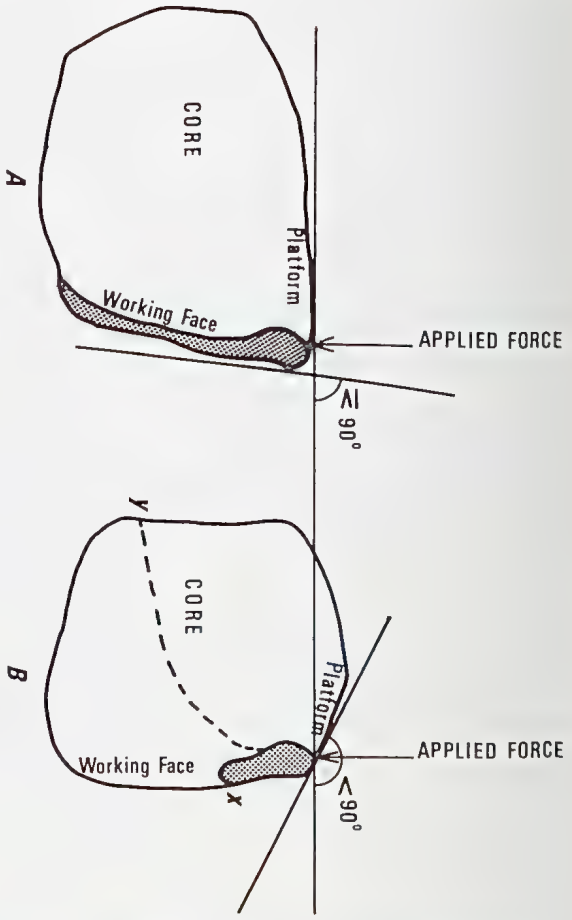

Fig. 3. Platform-to-working-face angles on percussion cores. **A:** technically correct angle; **B:** technically incorrect angle. Note hinge termination (**X**) and reverse hinge termination (**Y**).

ventral surface of large macro-flakes served as a single facet platform and micro-flakes were produced from the dorsal surface of the original macro-flake. In addition, exhausted cores of this type were often used as tools if they met the rather loose morphological requirements of the potential tool user.

Specific or individual platform preparation for the removal of macro-flakes was frequently necessary for successful flake removal. One of the most common Aboriginal methods of preparation was by rubbing the hammerstone over the edge of the core platform, thus removing the 'lip' or 'overhang' while creating small stacked step fractures on the face of the core (Fig. 9). This method of individual flake platform preparation allowed the flakes to be produced with small flake platforms, less curved in long section and often with smaller bulbs of force. In prehistorical Australian collections this platform preparation technique has been very frequently mis-identified as 'use-wear' on many cores such as 'horsehoofs'. We suspect it is mis-identification of platform preparation techniques which has led many workers to identify these cores as tools (Kamminga, 1978:308-320, with refs). More recently, Lampert (1981:Ch. 4) assumes that horsehoofs are tools and compares them with hand-held chopping implements used recently in central Australia (Hayden, 1979). However, none of the tools illustrated by Hayden display the overall morphology or edge-fracturing apparent in Lampert's samples, and we reject his comparison and conclusion.

Although some of the cores may have been used as tools, there is little direct evidence of this. Kamminga (1978:310–314) microscopically examined 41 horse-hoof cores from a number of archaeological sites and detected clear use-wear on only one, and probable use-wear on another. We repeat that the stacked step-fractures resulting from platform preparation are a characteristic marker of non-rejuvenated cores.

Stage III: Production of Blades and Cores. As flaking continued, the knapper was able to produce macro-flakes which were more regular in shape and size. Linear flakes, about twice as long as they are wide and with sub-parallel margins and dorsal ridges, could also begin to be produced. The change from macro-flakes to linear flakes was the result of a deliberate

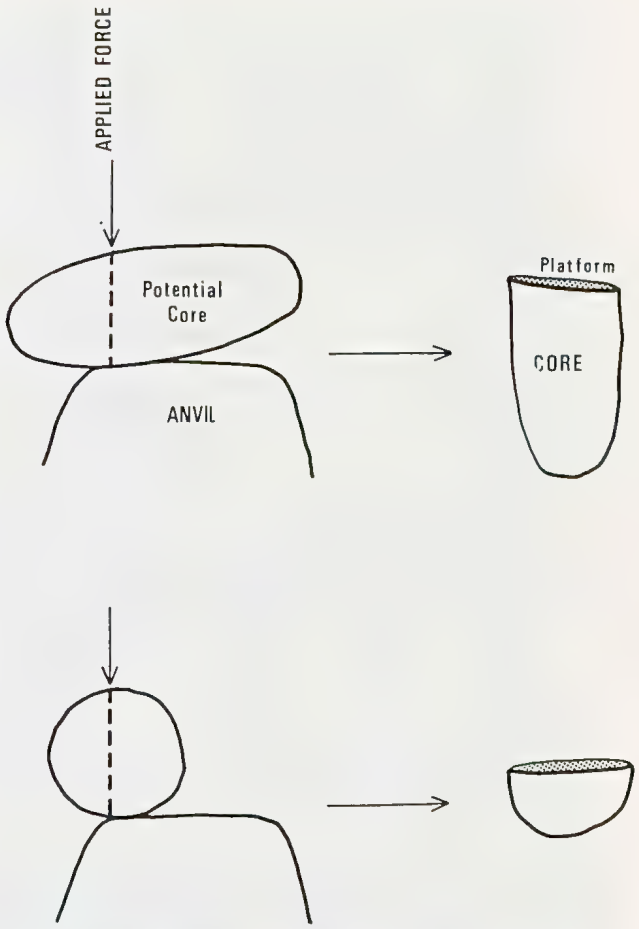

Fig. 4. On-anvil method: a method of single facet platform preparation on large, rounded to sub-rounded lithic materials.

change in technique, in bringing platform contact points (where the hammerstone contacts the core platform) closer together (Fig. 10). The shift between linear flakes and true blades was also an intended technical change determined by the Australian knapper.

The success of these changes was determined by the knapper's ability to maintain straight, closely spaced ridges or arrises on the working face of the core (Fig. 11). Actual ridge maintenance was required prior to blade production since some ridges, or previous linear

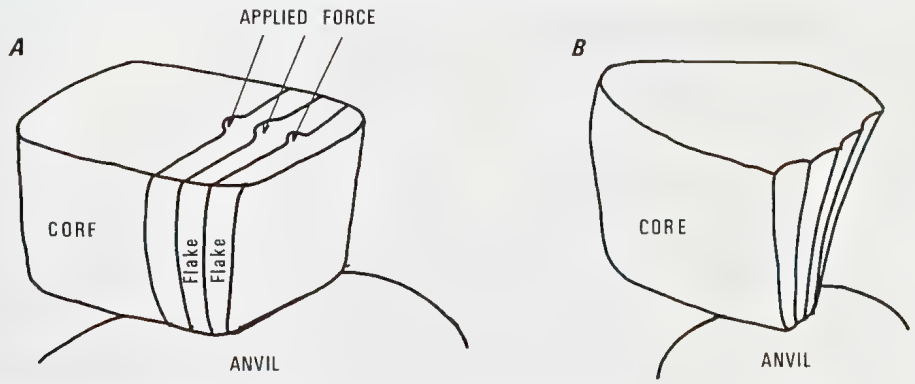

Fig. 5. Diagrammatic illustration of two bipolar techniques. **A:** 'sectioning' a large angular block; **B:** producing flat flakes.

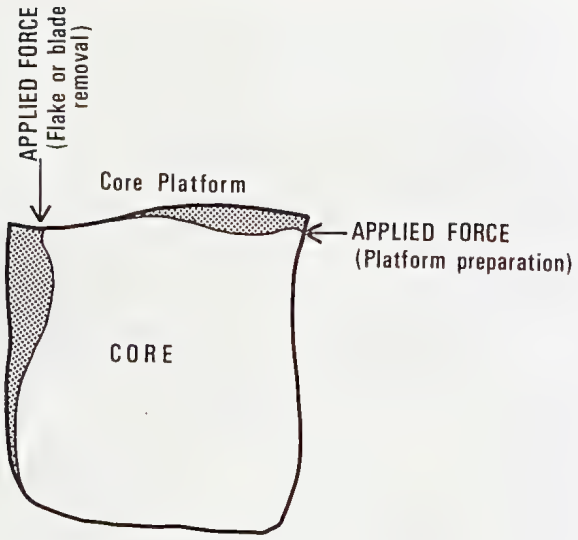

Fig. 6. Continuous platform faceting or preparation as a result of loss of technically correct angle after flake or blade removal. (See also Fig. 4)

flake scar margins on the face of the core, required alteration by flaking in order to 'straighten' the ridge for blade removal (Fig. 12). Small percussion flakes were removed from one side of any sinuous ridge thus making the ridge straight or in line from the proximal to the distal end of the core. This maintenance technique meant that the blade produced from that location on the core would be straight with parallel sides. It is a mechanical fact that flake or blade shape in plan or outline is largely dependent upon surface topography of the core since a fracture will follow the area of higher mass, i.e. a ridge or arris. Therefore, by straightening a sinuous ridge on a core, both before blade removal and during the sequence of blade removal (as a rejuvenation technique), the subsequent blades will have parallel margins.

In order to produce successful blades not only must straight ridges be maintained but also the working face of the core must be kept rounded when viewed from above the platform. The less rounded (flatter) the core working face, the wider the blades or flakes will be (see Fig. 10).

True blades are intentionally prepared. They are specialized flakes at least twice as long as they are wide, with sub-parallel to parallel margins and the dorsal arrises or ridges parallel to the long axis of the blade (Fig. 13). Within the Australian reduction technology, true blades were produced until the core became exhausted or too small and irregular due to mistakes or internal checks (fractures or other unconformities in the stone). The determination that a core was 'too small' depended upon the raw material. Cores of coarse, hard stone that was difficult to work were frequently 'exhausted', even though they were still fist size, because it became too difficult to support the core by hand and drive off flakes by direct free-hand percussion. The horsehoof cores of the 'Kartan' are good examples of exhausted cores of this nature (Lampert, 1981).

At this point in the reduction sequence, if linear flakes were again desired, they were produced from the now irregular 'blade' core. Linear flakes were produced within the reduction sequence both before and after true blade production.

Occasionally, very thick macro-flakes and linear flakes would serve as blade cores when the intended end products were blades that were triangular in cross-section (Figs 14, 15). A platform was prepared at one end of the flake by unifacial flaking or 'backing'. Then, a blade, triangular in cross-section, was struck by direct free-hand percussion from the margin of the flake. Frequently, these cores are referred to in the literature as 'burins' (e.g. McCarthy, Bramell & Noone, 1946:33). We discuss the occurrence of functional burins in Australia below.

Stage IV: Production of Micro-Flakes and Cores. As the reduction sequence continued, the core and flakes became more irregular, like those produced at the beginning of the sequence (Figs 16, 17). The main difference between macro-flakes and micro-flakes is, as their names imply, size. Micro-flakes are wide and irregular in plan, have faceted or natural platforms and frequently terminate in a hinge. Micro-flakes are defined in comparison with macro-flakes within one technological reduction sequence. Size, shape, petrology and specific reduction technique will determine the size ranges of macro-flakes, linear flakes, blades and micro-flakes: they are context-dependent.

During this stage of reduction, the core frequently became too small to reduce it any further as a single

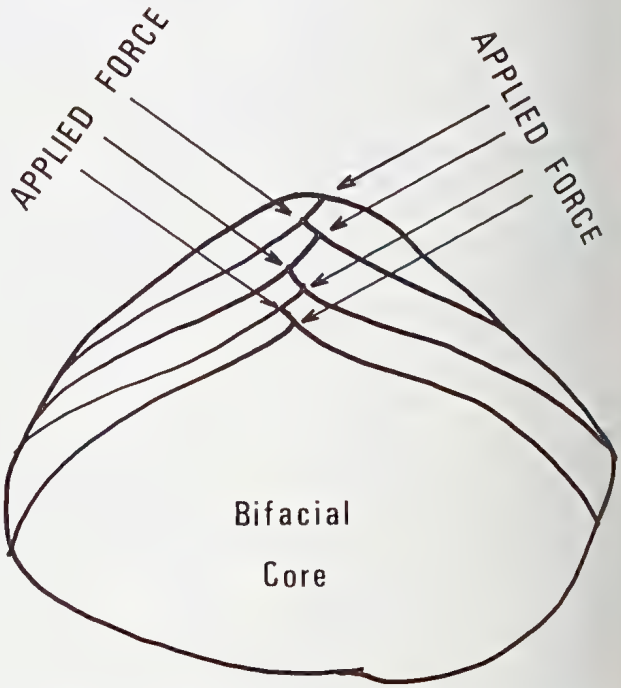

Fig. 7. Diagrammatic cross section of bifacial core where each flake platform was created by previous flake removals. Seven flakes have been removed.

Fig. 8. Flake core. **Top left:** proximal (platform) view. **Top right:** distal view. **Below:** lateral view. Winbar, western N.S.W.

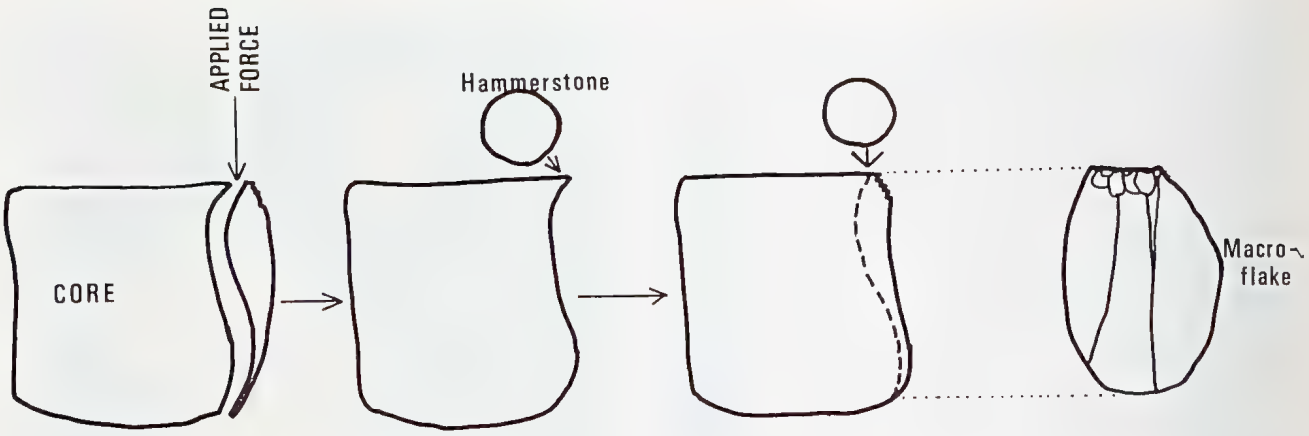

Fig. 9. Technique of individual flake platform preparation. Note that stacked step fractures on the dorsal surface result from platform preparation.

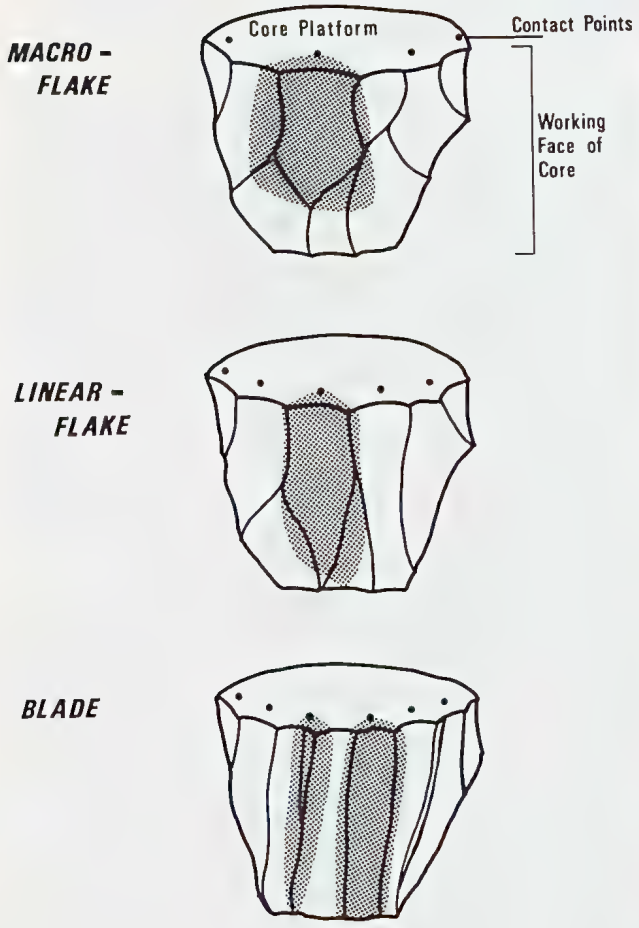

Fig. 10. Flake and blade production. Note distances between contact points on each core, and rounded working face of cores.

Fig. 11. Blade core. Note parallel arrises on working face of the core. Jubilee, near Andamooka, Lake Torrens.

Fig. 12. Ridge or arris alteration blades ('redirecting flakes') to 'straighten' ridges for blade removal. Singleton, NSW; L–R: E50893, E50893, E50441, E50438.

Fig. 13. True blades. Note parallel margins and arrises. Singleton, NSW; E50889, E50464, E50464, E50464.

Fig. 14. Blade cores produced on macro-flakes and linear flakes. Blades were removed from the original flake margins. Singleton, NSW; L–R: E50218, E50891, E50891, E50891.

Fig. 15. Macro-flake employed as a blade core. Singleton, NSW; E50218.

platform core. Therefore, other locations on the core served as one or more platforms if the appropriate angles were present (see stage II). These locations were prepared by flaking, or served as platforms without any additional modification.

It should be noted that single platform cores were transformed into multi-platform cores at all stages of the reduction sequence. The change from single to multi-platforms depended upon core size, shape, internal checks, or desired flake production.

Stage V: Exhausted Cores. A core became 'exhausted' when it no longer functioned as a core. Lack of bulk material was not the only reason to discard a percussion core. Core abandonment was frequently a result of small size or difficulty of holding, extremely tough or coarse material in relation to size, material hardness, size of the intended tool, availability of raw material, internal checks, excessive mistakes, and/or platform-to-working-face angle becoming greater than 90°.

Reduction technique may have changed when a direct free-hand percussion core of good quality became too small. Often an exhausted direct free-hand percussion core was further reduced by a bipolar technique (see footnote 2). Some bipolar techniques offer the benefit of producing long, flat, sharp flakes from extremely small cores. Eventually, the bipolar core either totally shattered or became too small to work any further. At this stage, the core (frequently referred to as a 'fabricator', see White, 1968b) was discarded into the archaeological context.

Sometimes small cores of good quality material were reduced into flat, bifacial cores, almost square or rounded in plan. These produced small, flat micro-flakes (Fig. 18).

Fig. 16. Sequence of flakes and blades representing the Australian flaked stone tool reduction system. Bondi, NSW; L–R, Top: E11507, unnumbered, E16378/53, E16378/33, unm, unm; Base: unm, unm, unm, E16377/13, unm, unm.

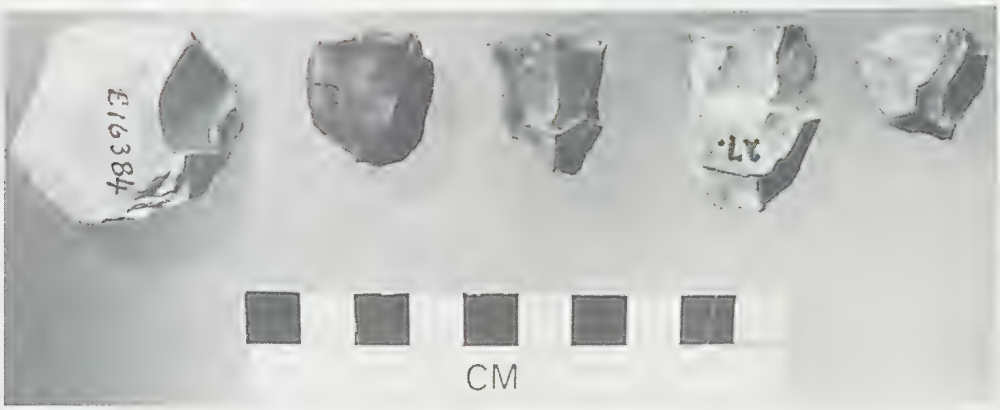

Fig. 17. Sequence of cores representing the Australian reduction system. Bondi, NSW; L–R: E16384/33, E16383/3, E9072, E16383/27, E16383/30.

Fig. 18. Exhausted bifacial cores. Inverleigh, Vic.; All: E52612.

Fig. 19. Exhausted bipolar core which has been subsequently altered, as witnessed by the striations along one edge. Bondi, NSW; E16378/24.

Exhausted cores, of any type, were employed as tools if the core had the necessary attributes required by the user. For example, a bipolar was employed as a tool at the Bondi site (Fig. 19), and Lampert (1971:46) gives other examples. Such recycling further supports the thesis of the opportunistic nature of Australian technologies.

Australian Flaked Stone Artefacts

Tula adze. The flakes employed for the manufacture of tula adzes were perhaps the first formal flake type produced within the Australian reduction system (Fig. 2). They were produced during stage II, the production of macro-flakes. Classic tula adze flakes were produced within a definite size range, were rounded in plan view, possessed a shallow V-shaped, natural, single or multi-faceted platform, a large, pronounced bulb of force, and were slightly concave on the ventral surface below the bulb of force (Fig. 20). For further details on tulas see Sheridan (1979).

In situations where raw materials were small in size, of poor flaking quality, or not readily available, tula adze flake attributes were less restrictive. In other words, a specific set of morphological attributes was preferred by Australian knappers for tula adze flakes but not necessarily adhered to. Therefore, a very wide morphological range of prehistoric tula adzes and adze slugs exists.

Acceptable flake size for a tula adze was dependent upon hafting and intended use. Flakes that were too large or too small would not be easy to haft, or effective in use.

The rounded shape in plan of a tula adze flake was either produced intentionally as a result of core preparation, or was the result of unifacial flaking from the ventral surface. A working edge rounded in plan (from side to side) was preferred because it would not let the adze bit 'bite' into material being worked and break the adze or the haft. When the platform end of

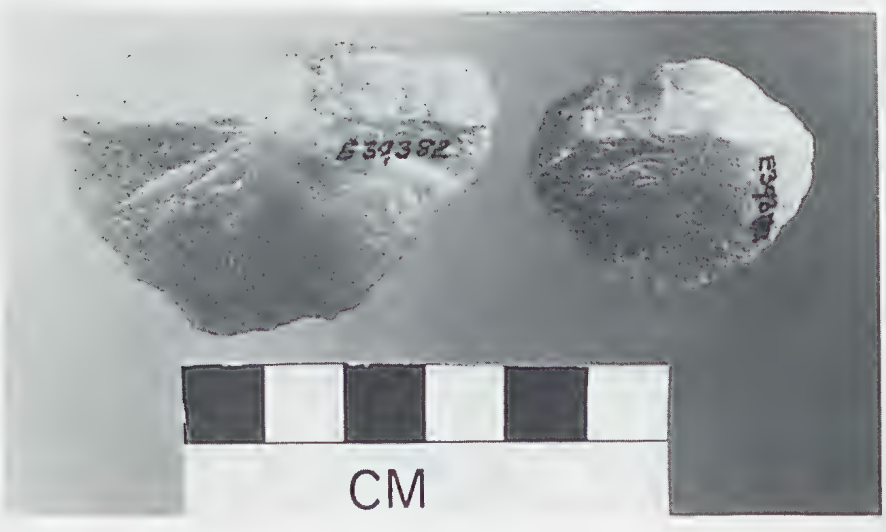

Fig. 20. Tula adze flakes. Inverleigh, Vic.; E39382, E39388.

the adze flake was used, the bulb of force provided the rounded working bit.

The V-shaped natural, single or multi-faceted platform on a 'classic' tula adze flake was intentionally created by the removal of a small flake or flakes from the core at the location of the potential dorsal surface of the adze flake (Fig. 20). These smaller flakes were removed in order to set the contact point of the adze flake back further into the core's platform, so creating a more pronounced bulb of force when the adze flake was produced. This pronounced bulb of force, which caused the concave ventral surface below the bulb of force, was required to create a functional adze, which would push the shavings off the wood (Sheridan, 1979).

In addition, the removal of these small flakes played another important role. When associated with the V-shaped (natural, single faceted or multi-faceted) platform, the removal of these flakes (removed while the potential adze flakes remained on the core) caused the force loaded into the stone (percussion flaking) to spread around this much stronger flaked area, thus creating a much wider than necessary platform (Fig. 20). This wider platform served as the second, or opposite, edge on the adze after the adze flake was removed from the core.

The V-shaped platform of a 'classic' tula adze flake also had a slightly convex surface from side to side (Fig. 20). This convex surface was created naturally or intentionally when the core was prepared. When the core was a large flake with a single facet (ventral surface of flake) platform, potential adze flakes were removed from the slightly convex surface of the bulb of force on the core's platform. If the core's platform was flat, flakes were removed from the platform to provide a slightly convex core platform which created adze flakes with multi-faceted platforms. This slightly convex core platform aided the prehistoric knapper in predicting the desired flake morphology and termination.

Burren adze. The burren adze as an artefact type is far less formalized than the tula adze. Burren adzes were manufactured on linear flakes or true blades due to the fact that, by definition, the platform of the adze flake or blade remained intact at one side of the adze bit. The bit or bits of the burren adze were established at opposite sides of the long axis of the flake or blade preforms (Mulvaney, 1975:82–3). Burren adze preforms usually had convex ventral surfaces in order to increase the effectiveness of the adze.

As with most other Australian flaked stone tools, burren adze morphology was subject to size, quality, availability and quantity of raw materials. The fact that both burren adzes and tula adzes are sometimes found archaeologically in the same context may indicate an economical use of stone rather than that adze preforms were culturally or functionally defined. Further studies of the distribution of both forms is required.

Backed artefacts. The specific process of 'backing' artefacts as a pattern of behaviour required a reduction technique separate from all others found in prehistoric Australia. Backing as a technique, however, had the same technical attributes as all other bipolar techniques, and these have been common in Australia for at least 30,000 years. There are four technical attributes which demonstrate that backing is the same as other bipolar techniques (see footnotes 2, 3). These are:

(i) the use of anvils to support small masses (small artefacts),

(ii) the use of anvils to support small artefacts, increasing predictable fractures,

(iii) the use of anvils to increase flaking efficiency by 'bipolar' and 'shearing' actions; anvil often acts as percussor during reduction process (double backing), and

(iv) all are accurate methods of reducing lithic mass, and are economical in terms of time and energy.

Thus 'backing' as a technique should not be perceived as something 'new' within Australia. Rather, it appears to us to be readily derived from techniques widespread within the country.

The formal properties of 'backing' which identifies 'backed artefacts' have been debated at length (e.g. Croll, 1980; Dickson, 1975; Glover, 1969; McCarthy, Bramell & Noone, 1946:36; Pearce, 1973, 1977; Wieneke & White, 1973). The backing process was conducted by placing the potential artefact (linear flake, blade or micro-flake) on a narrow anvil such as the poll of a hatchet (Fig. 21) and, by percussion, chipping away the unwanted mass of stone to form a blunted edge. A narrow anvil was used to allow the knapper greater freedom of movement while holding the potential tool. Stone was the most likely anvil material since it gave the firmest support and actually served as a percussor during the backing process when the backed edges approached 90°. Therefore we consider that 'double backing' was most frequently caused by a bipolar action where both the anvil and the hammerstone functioned as percussors (Fig. 22). We note that there are many pitted hatchet polls and anvil stones in the Australian Museum collections, especially from the coast south of Sydney where backed blades are extremely common.

The amount of lithic mass removed from a tool preform to produce a functional tool depended upon the preform morphology and desired artefact width, and was not a locally patterned 'cultural' style (Fig. 23). First, the margin that was the sharpest and straightest was selected as the chord while the opposite lateral margin, the more irregular of the two, was backed. This created either a 'right' or 'left' backed artefact. If the dorsal ridge was situated close to the margin to be backed and/or the preform was near to desired shape prior to modification, then minimal mass was removed to form a functional backed artefact (Fig. 23A). Furthermore, backing was often restricted to small areas of the tool's margin. In this situation, the anvil only supported the light weight of

Fig. 21. Hatchet poll probably employed as an anvil. Manly, NSW; E60730.

Fig. 22. 'Double' backing on a Bondi point. Singleton, NSW; E49129.

the preform, and anvil 'contact'[3] with the potential tool never occurred, leaving the backed edge unifacially rounded.

A second 'style' of backing required the entire margin to be altered due to preform morphology (too wide or irregular). But with the dorsal ridge more or less in the centre of the preform, anvil contact may not have occurred, leaving the edge backed from one side and rounded on the other (Fig. 23B). A third 'style' of backing resulted when anvil contact did occur, and in this case the backed edge was 'squared-off', being flaked from both sides (Fig. 23C).

We consider that by taking a technological view of these artefacts a number of their 'puzzling' aspects are explained. The percentages of 'right' and 'left' hand backing, of backing from one or both sides and the length of retouching can all be considered to result from specific contextual circumstances, such as the nature of the particular pieces of raw material available, the knapper's skill, etc. We suggest that the occurrence of geographical or temporal patterns in the attributes (Pearce, 1973) is best explained in this way.

Within 'styles' A, B and C of Fig. 23, a dorsal ridge(s) still appears. Prehistorically, however, the backing process may have removed all evidence of a dorsal ridge(s) (Fig. 23, D–F). This can occur because of desired tool width, sinuous ridge(s) and/or manufacturing error.

In situations where a part or all of the margin to be backed was quite thick, the backing process often left the margin bifacially rounded due to the process of shearing (Fig. 23F). Because the preform was thick, flakes were removed from both edges (by hammerstone and anvil edge). However, the potential tool was not hit hard enough to allow the force to travel completely through the mass and, therefore, small flakes were removed from both edges, travelling a very short distance and leaving the backed edge bifacially rounded. The knapper's percussion force was not increased for fear of breaking the artefact in half. Figure 24 illustrates the various technical forms of backing on Bondi points.

Bondi Points and Geometrics. All Bondi point and geometric preforms were relatively flat in long-section, had at least one fairly straight, sharp margin, a relatively thin cross-section and none to more than one dorsal ridge. The actual number of dorsal ridges does not seem to have been an important factor. Most

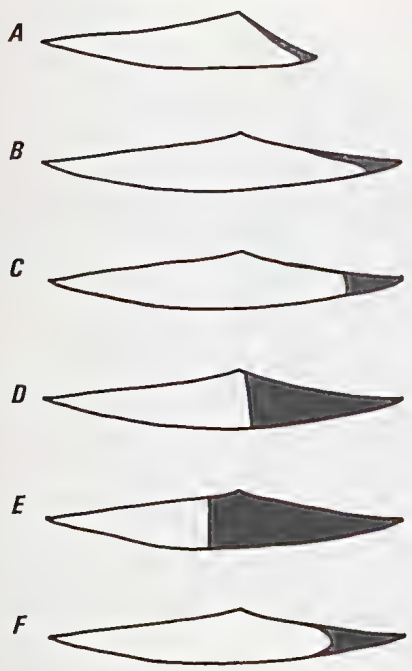

Fig. 23. Technical 'types' or 'styles' of backed artefacts, viewed in cross-section.

preforms were, however, either triangular or trapezoidal in cross-section due to one or more than one dorsal ridge, respectively. This loose definition of Bondi point and geometric preforms illustrates the opportunistic nature of preform selection. It also suggests that 'types' should be examined technically in the first instance.

Both backed artefact classes have three attributes in common: one or more points, one fairly (but not necessarily) straight, sharp edge and one or more backed margins. Technically, based upon the above discussion concerning backing, there is only one 'type' or 'style' of Bondi point and geometric. Quality, quantity, availability and size of raw materials often placed restrictions upon Bondi point and geometric manufacture which created a wide range of morphologically divergent, but technically the same, backed artefacts.

The elouera has also been placed by typologists into the 'backed artefact' category (Mulvaney, 1975; Kamminga, 1978). The above discussion concerning 'backing' applies to artefacts loosely defined as eloueras in southeastern Australia (see Kamminga, 1978 for further data).

Burins. True, technical burins (i.e. not flakes so snapped by chance during flaking) manufactured on blades did exist in prehistoric Australia. They may have been used in some situations to groove bone or wood.

Perhaps the most conclusive archaeological evidence of burins associated with grooved bone comes from the Jack Smith Lake site (East Gippsland) on the south coast of Victoria (inspected by courtesy of K. Hotchin and P. May). Many other prehistoric Australian lithic assemblages such as the Ingaladdi site in the Northern Territory contain some true burins (D.J. Mulvaney, pers. comm.). The lithic analyist must, however, be certain of the differences between true burins and blade cores manufactured on large macro-flakes with similar morphological attributes (see end of section entitled "Production of Blades and Cores"; cf. also Crabtree, 1972; Brezillon, 1968).

True technical burins were manufactured on linear flakes or true blades (Fig. 2). Once the flake or blade preform was selected for alteration, a platform was produced at one end (usually the distal end) of the preform by the backing technique discussed earlier. The backing technique allowed the platform to be flat or perpendicular (at 90°) to the burin preform margin, a requirement for proper burin spall removal. Mass was removed until full contact with the stone anvil was established thus creating the necessary 90° platform-to-margin angle. If full anvil contact was not established, then a rounded platform (from dorsal to

Fig. 24. Backed artefacts (mostly Bondi points) with various amounts of backing due to preform size and desired shape. Bondi, NSW; L–R: unnumbered, unm, E9056, E16375, E16375, E9080, E9080, E16375, unm, unm, unm.

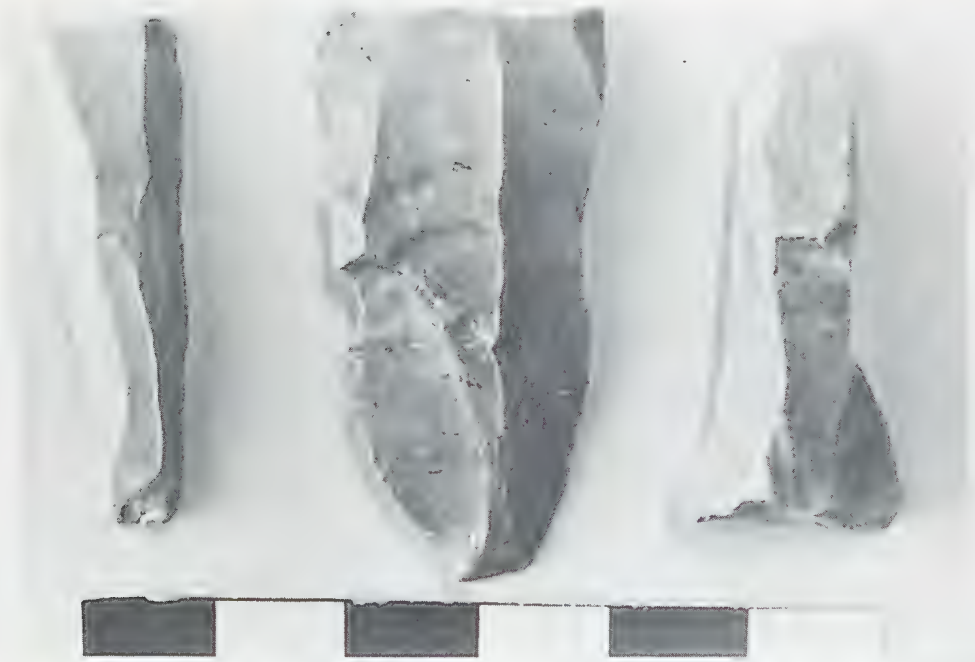

Fig. 25. Burins. Left: displays platform and margin preparation; centre: single burin spall removed from the right margin; right: multiple burin spalls removed from right margin and platform. Jack Smith Lake site, Vic.

Fig. 26. Burin spalls. Jack Smith Lake site, Vic.

ventral surfaces) would be created. This would not allow correct margin or burin spall removal (see Fig. 23A, B, F). After platform preparation, the preform's margin was straightened and strengthened by light percussion retouch unifacially applied from the ventral surface to the margin from which the 'burin spall' was to be removed (Fig. 25 left). At that stage, the burin spall was removed by either direct free-hand percussion or the on-anvil percussion technique (Figs 25 centre, 26). If a successful spall was created, the burin was then ready for use (Figs 25 right, 27).

The working edge (or bit) of the burin was the negative bulb of force and was V-shaped, which provided a strong, sharp edge for grooving bone or wood.

This burin edge could be applied to bone or wood either in the same plane as the V-shaped bit creating a V-shaped groove, or at right angles to the V-shaped bit creating a U-shaped groove the width of the burin bit. In addition to the use of the burin bit, the lateral margins of the burin spall scar were ideal obtuse angle cutting edges and were most certainly employed prehistorically to shave down wood or bone (Crabtree, 1973). Once the bit of the burin became dull through use another spall was removed from the same flake or blade margin, creating a new, sharp burin bit as well

Fig. 27. Burins. Jack Smith Lake site, Vic.

Fig. 28. Grooved bone found in association with burins. Jack Smith Lake site, Vic.

as a new obtuse angle tool (Fig. 25 right).

Burin resharpening also occurred by removing additional burin spalls from what once served as a faceted platform for the removal of the first burin spall (Fig. 27). In addition, this action changed the bit angle of the burin from 90° to considerable less than 90°. More acute bit angles on burins were necessary when the groove in the bone or wood became too deep to work efficiently with a 90° angle without making the groove considerably wider at the outside surface of the groove (Fig. 28). Once a burin was exhausted by numerous resharpenings, it was discarded.

Points. From a technical perspective, the different point 'types' found throughout Australia form a single, uninterrupted continuum (Fig. 29). This technological fact once again demonstrates the opportunistic and economising nature of prehistoric Australian technology.

The simplest type of point found archaeologically as well as ethnographically in Australia was the unmodified 'pointed' true blade or linear flake. If the core was prepared correctly and the knapper's aim was true, a blade, triangular in both cross-section and plan, was produced. It required no modification in order to function successfully as a lethal projectile point. This point type was either a direct result of intentional core preparation for the production of triangular points, or more often, suitable pointed blades were selected from numerous blades produced in one or more reduction sequences (Thomson, 1949: 55). The size of these points depended entirely upon the physical attributes of the raw material, its size range and the knapper's preference.

If a flake or blade did not meet the knapper's concept of a 'point', modification by percussion and/or pressure was required. The extent of modification depended upon the original morphology of the preform as well as on the knapper's concept. Techno-

logically, the simplest form of modification was to unifacially retouch the dorsal surface. This created a unifacial point.

When the point preform was very irregular and thick, then platforms had to be established on the ventral surface along the preform's margin in order to detach flakes from the dorsal surface. Platform preparation was usually in the form of small flake removal in addition to heavy abrasion. This action frequently left small flake scars on the ventral surface of the completed point. Technically, a point of this type can still be considered a unifacial point.

Frequently, a flake or blade was morphologically suitable as a point preform but the potential base (proximal, bulb of force end of the flake or blade) was too thick for proper hafting. In this situation, the bulb of force on the ventral surface was thinned by percussion and/or pressure flaking. Technically, even if the dorsal surface of the point was modified in association with ventral surface basal thinning, the point is still a unifacial point, as Mulvaney notes (1975:219).

All of the unifacial point types defined above are plano-convex in cross-section (Fig. 29). The attempt to change a plano-convex cross-section into a bi-convex cross-section resulted from a deliberate technological change designed to produce a 'bifacial point'. To produce a point with a bi-convex cross-section, the knapper had to establish platforms on the preform by first removing flakes from the ventral surface (Fig. 30A) and then abrading the margins. This action moved the margins of the preform toward the middle of its mass so that flakes could be removed successfully from both faces (Fig. 30B–E). This technique produces a true bifacial point (Figs 29, 30E).

We therefore can demonstrate, on the basis of point cross-sections, the only technical difference among prehistoric and recent points in Australia is between unifacial points ('points', 'unifacial points', and 'pirri points') and bifacial points ('bifacial points' and 'Kimberley points') (Fig. 29).

Flaking techniques employed to produce points can be briefly discussed here. Direct free-hand percussion and bipolar techniques (Fig. 5B) were employed to produce both the flake or blade preform and, in many situations, to modify the preform into the desired shape. Pressure flaking was also often employed to modify preforms into both unifacial and bifacial points. We think, however, that pressure flaking was used primarily to deal with particular preform morphologies (thin, small, etc.) and was not a culturally dictated pattern. It should not, that is, be used archaeologically as a particular cultural indicator. We say this because we have observed pressure flaking on many pirri points, and even on some with lesser amounts of surface modification. We suggest that the technique of pressure flaking was known thoughout all areas of Australia in which points were made. We stress that this knowledge, as far as we can tell, has nothing to do with blade production, but is a technique for surface and margin modification.

Miscellaneous flake tools ('scrapers') and 'utilised flakes'. Miscellaneous flake tools are the most common artefact 'type' recovered from prehistoric Australian sites. These artefacts possess no common set of diagnostic morphological attributes. Their presence, indeed their frequency, illustrates the opportunistic nature of Australian technologies.

Miscellaneous flake tools can be divided into two categories for analytical purposes: unmodified flake tools and modified flake tools.

(i) The unmodified flake tools can be distinguished as tools, if at all, only on the basis of having abrasive

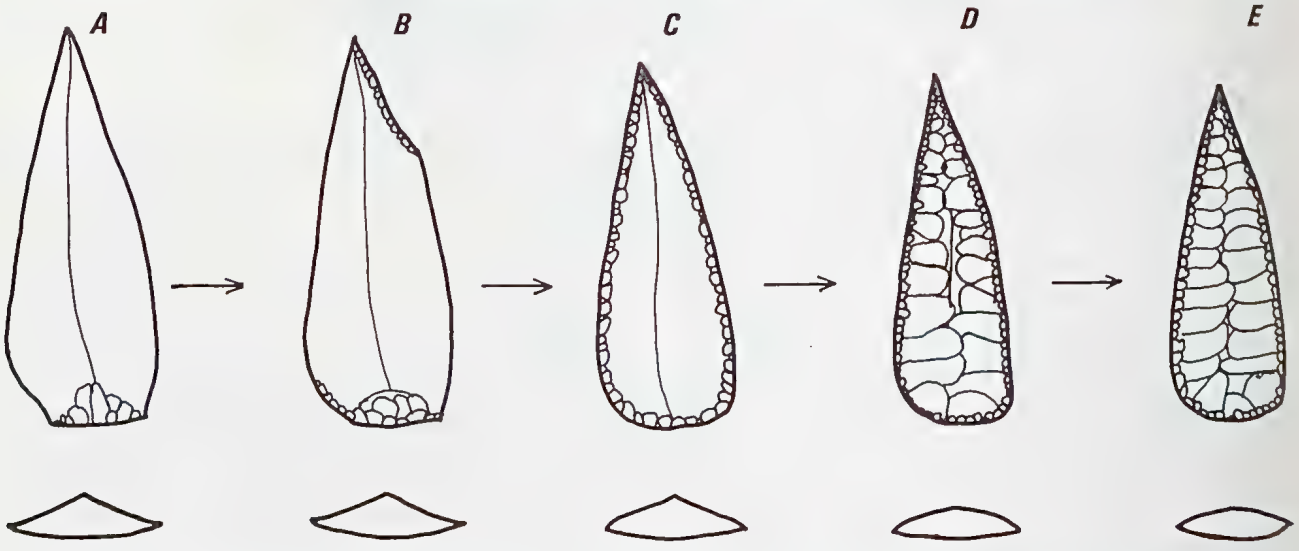

Fig. 29. Technological sequence of Australian points. **A:** no modification; **B:** tip and base modification only; **C:** 'unifacial point'—total margin modification; **D:** 'pirri point'—total dorsal surface modification; **E:** 'bifacial' or 'Kimberly Point' — total dorsal and ventral surface modification. Note that only E has a convex ventral surface.

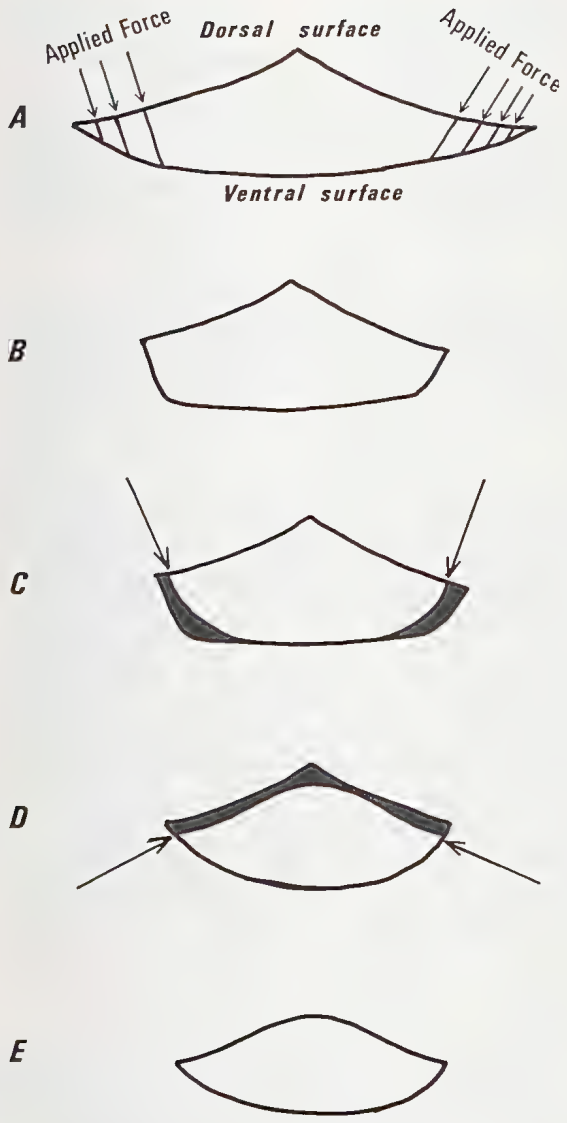

Fig. 30. Sequence for the production of a bifacial point. **A:** margin moved to centre of preform mass; **B:** ventral surface modification; **C:** further ventral surface modification; **D:** dorsal surface modification; **E:** bi-convex cross-section of a bifacial point.

wear as well as edge flaking since the latter can readily be produced by intentional or unintentional edge modification (e.g. Ahler, 1979:305; Keeley, 1980:Ch. 3). Distinguishable kinds of abrasive use-wear will allow different uses of tools to be distinguished, although this process will clearly be a tedious one.

(ii) The determination of flakes as modified flake tools is the most difficult analytical problem facing archaeologists world-wide. The presence of 'modified' edges on a flake does not automatically designate it as a prehistoric tool. 'Modified' edges can and frequently did occur naturally through post-depositional agencies such as trampling and soil movement (e.g. Knudson, 1979; Flenniken & Haggarty, 1979). These naturally modified flakes possess no form of use-wear abrasion. Without abrasion, it is virtually impossible to define flakes as tools because the same mechanical actions that modified the flakes naturally were also used by humans to modify the flake tools prior to the establishment of use-wear abrasion (cf. Hayden, 1979; Keeley, 1980; Semenov, 1964; Flenniken & Haggarty, 1979).

We therefore suggest that 'modified flakes' including 'scrapers' must either possess abrasion and/or striations, or diagnostic humanly-produced flaking (such as pressure flaking) in order to define them as flake tools. Intentionally pressure flaked edges leave diagnostic traits such as evenly spaced flake scars, regularly spaced micro-serrated edges, flake scars terminating in feather or micro-step fractures, as opposed to stacked step fractures and crushing, and flake scars travelling onto one or both faces of the flake. Without such demonstrable evidence, flakes should not be defined as tools. We know of no attempts to systematically apply such criteria to Australian assemblages (cf. Hiscock, 1983).

Conclusions

This paper has made a number of assertions about techniques used in and technologies of prehistoric Australians. These assertions are primarily based on JJF's expertise in flintknapping, and are testable only by people who have themselves some knowledge and ability in this technical area. Many aspects of stone working are readily appreciated only by people who have learned to do it for themselves and who can understand not only what was done in certain contexts, but why. We expect that within the next few years our assertions, which are based primarily on museum collections, will be tested by the detailed analyses of techniques employed at particular places and times by prehistoric Australians. Technological analyses of assemblages are clearly necessary to give a diachronic perspective of our claims (cf. for example, Flenniken, 1981; Bucy, 1974). The major conclusions we derive from our study are:

1. A single reduction sequence has been common to the whole of Australia throughout its prehistory. This means that the technical origins of major changes in formally shaped tools do not need to be sought externally. We have seen no evidence that a technique of producing blades by indirect percussion (punch technique) was ever present here. 'Backing' on artefacts is a simple application of a bipolar technique known in Australia since the Pleistocene.

2. Australian stone technologies have always been opportunistic, taking full advantage of whatever the environment offered. By this we do not mean that there was laziness or carelessness, but that stone tools were very largely the result of the least possible effort necessary. If a cortex-backed flake could be used instead of a backed blade, or a naturally triangular pointed flake was available, then these tools were used. The one situation where this does not seem to be so is in the production of bifacially flaked bi-convex points.

3. Many of the smaller typological categories based on morphological variation within broad classes (backed artefacts, unifacial points, scrapers) are as much the result of variations in size, availability and exact nature of raw material along with knapper's skill as they are of deliberate design. Analyses of assemblages need to start with technological studies, and use 'cultural' variation only as a residual category.

4. This same principle should also apply to the analysis of cores and 'scrapers'. The 'retouched' and 'utilized' edges on many of these are the result either of continuing attempts to remove flakes from refactory raw material or the unintended result of natural and cultural processes acting on unmodified pieces of stone (cf. Flenniken & Haggarty, 1979). It is worth noting here that in the Australian ethnographic record (e.g. Daisy Bates in Wright, 1977; G. Aiston in Horne & Aiston, 1924:91–2; Hayden, 1979) the majority of scraping tools (other than hafted adzes) were not 'retouched' into shape, or were only adventitiously so. Thus there seems to be a discontinuity between present behaviour and the many interpretations of past technologies which have focused entirely on pieces with apparently deliberate retouch (e.g. McCarthy, Bramell & Noone, 1964; Mulvaney & Joyce, 1965; Jones, 1971; White, 1972; Lampert, 1981). We suggest that it might be useful to assume that our ethnographic records are a good guide to the past, and to look at archaeological assemblages more in the light of them.

Footnotes

1. Flenniken has some 20 years experience of knapping, which he has been teaching and researching in full-time for 8 years. During 6 months in Australia he worked through all the sequences described here and participated in a week-long workshop with Australian knappers including K. Akerman, P. Bindon, R. Fullagar, B. Cundy, P. Hiscock and D. Witter. Collections inspected included Australian Museum (2 weeks), Western Australian Museum (2 days) and short visits to several others.

2. Seven technically different bipolar techniques are known. Each leaves definably different debitage in an archaeological context (Flenniken, in press). The seven techniques are:
   (1) Small rock (pebble, flake, chunk, etc.) wrapped in cloth, bark, etc., placed upon a stone anvil, held lightly by the wrapping and smashed with a hammerstone. Useable pieces are selected out, the remainder is debitage.
   (2) Large (no larger than 10 cm in diameter), rounded rock, hand held on a stone anvil, split with a hammerstone to enter the rock and establish a percussion flake or blade core platform. Core platform was created as a result of a sheared cone leaving the core platform with no negative or positive bulb of force.
   (3) Small rock (pebble, flake, chunk, etc.) placed upon a stone anvil, split with a hammerstone and continued reduction via bipolar flaking. Platform preparation is carried out, and the morphology of flakes can be predicted. The bipolar core(s) remain as a result of the reduction process.
   (4) The same process as (3) except there is no flake prediction and the core is smashed for potentially useable pieces of stone.
   (5) The technique of 'backing' artifacts. See section of this paper entitled "Backed Artifacts".
   (6) A large angular block of material can be 'sectioned' by use of an anvil and hammerstone. The force is applied to travel through the core, producing large flakes, rectangular in cross-section (Fig. 5A).
   (7) Same process as (6) except flakes or blades are produced from the core. Use of the anvil allows the flake or blade to be produced flat in long-section (Fig. 5B).

3. Anvil contact is defined as a bipolar percussion technique where force is allowed to travel completely through the preform's mass into the anvil. Flake removal may occur from either the hammerstone surface or the anvil surface (Flenniken, 1981).

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A New Australian Scincid Lizard, *Ctenotus coggeri*, from the Alligator Rivers Region, Northern Territory.

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Sydney South, 2000

ABSTRACT. *Ctenotus coggeri*, a new species of scincid lizard from the Northern Territory, is described. It is endemic to sandstone woodland habitat on the Arnhem Land escarpment where it is sympatric with *Ctenotus inornatus*, the species with which it has previously been confused. Recognition of *C. coggeri* necessitated comparison with *C. inornatus* including the type specimen of *Hinulia inornata* Gray, the provenance of which is also reviewed.

Sadlier, Ross A., 1985. A new Australian scincid lizard, *Ctenotus coggeri,* from the Alligator Rivers region, Northern Territory. Records of the Australian Museum 36: 153-156.

Keywords: Taxonomy, Australia, Scincidae, *Ctenotus*

Arnhem Land is a region of heavily dissected sandstone, fringed north and east by coastal plains through which run extensive river systems to the Arafura Sea and Gulf of Carpentaria respectively. It is extremely rugged country with limited access. Consequently most knowledge of the Arnhem Land herpetofauna comes from surveys carried out on the more accessible western edge of the escarpment where it rises abruptly from the surrounding floodplain and lowland woodland associated with East Alligator River (Cogger, 1974; Mitchell, 1955; Sadlier, 1985).

Cogger (1983) depicts the diversity of habitats and herpetofauna to be found in the Alligator Rivers region and draws special attention to the high level of endemism associated with certain habitats, such as the sandstone outliers represented by Mt Brockman, Cannon Hill and Djawamba massif. It is from certain of these sandstone outliers that a new species of *Ctenotus* is here described.

Ctenotus coggeri n.sp.

Figs 1, 2

Type material. HOLOTYPE. Australian Museum (AM) R88547 (Fig. 1) an adult male from Jabiluka uranium mining project area N.T., grid reference 741113 on sheet No.5472 (Edition 1) National Map Series, 'Cahill', 12°33'S x 132°56'E.

PARATYPES. Six paratypes collected by R.A. Sadlier on the Jabiluka uranium mining project area: AM R88505 (3 August 1979), AM R88548 (5 August 1979) locality as holotype; AM R88835 (5 September 1979), AM R88930 (22 September 1979), AM R88931–88932 (23 September 1979) grid reference 747139, 12°32'S x 132°56'E.

Six paratypes collected by H.G. Cogger and D.A. Lindner at Koongarra, Mt Brockman, 12°52'S x 132°54'E: AM R38801, AM R38804–38807 (22 February 1973), AM R38954 (4 March 1973).

Diagnosis. The following suite of size, scalation and colour characteristics will distinguish *Ctenotus coggeri* from all other species in the genus: moderately large size (maximum SVL 80 mm); subdigital lamellae with broad dark calli; frontal contacting first three of four supraoculars, second widest; usually 8 upper labials; auricular lobules obtuse tending to form nearly continuous posterior free edge, grey in colour with fine dark spotting; uniform brown dorsal surface; uniform black upper lateral surface between fore and hind limbs; white midlateral stripe broken at groin but continuous with longitudinal stripe on hindlimb.

The first four features are characteristic of the *C. lesueurii* species group, of Storr *et al.* (1981), of which most members also have a well developed pattern of bold dorsal stripes and pale lateral spots between the fore and hindlimbs. *Ctenotus coggeri*, *C. quinkan* (tentatively placed in the *C. lesueurii* species group), poorly patterned *C. inornatus* and *C. helenae* lack these dorsal and lateral features of coloration.

Description. Large robust species attaining maximum snout to vent length (SVL) of 80 mm. Distance from axilla to groin 58.2–62.2% of SVL ($\bar{x}$

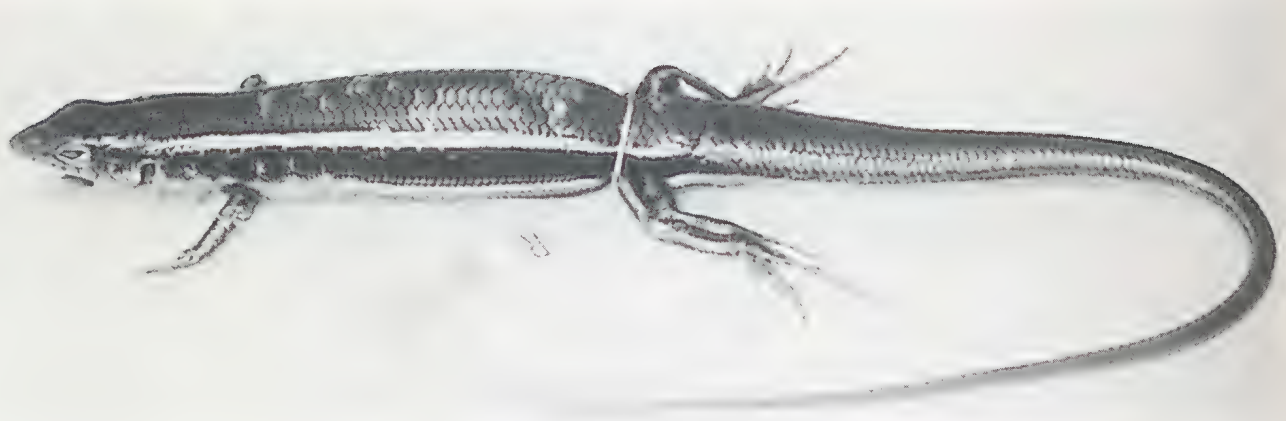

Fig. 1. Holotype of *Ctenotus coggeri* (AM R 88547).

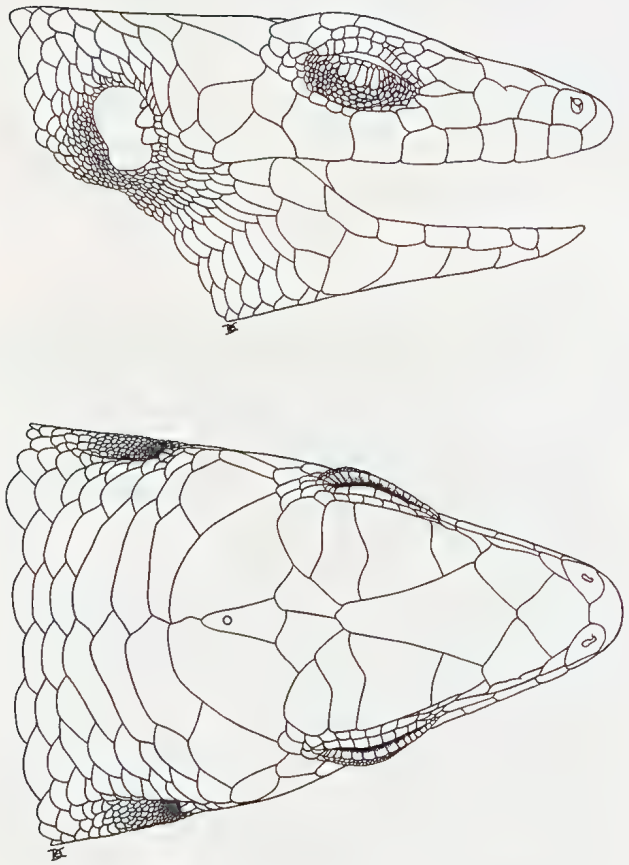

Fig. 2. Lateral and dorsal views of the head of the holotype of *Ctenotus coggeri* (AM R 88547).

= 59.9, N = 7); hindlimb length 42.9 - 48.5% of SVL ($\bar{x}$ = 46.0, N = 7); forelimb to snout length 33.3 - 35.8% of SVL ($\bar{x}$ = 34.5, N = 7); tail length 216.2 - 234.3% of SVL ($\bar{x}$ = 227.7, N = 4).

Head moderately broad and deep; nasals narrowly to moderately separated; prefrontals narrowly separated or in point to narrow contact; supraoculars 4, first three contacting frontal, second largest; supraciliaries 9 (92.3%, N = 7) or 8, first three largest, remainder much smaller and subequal; frontoparietals paired, distinct from interparietal; nuchals 2-3 either side ($\bar{x}$ = 2.9, SD = 0.4, N = 7); two loreals in horizontal series; single upper and lower preoculars, lower much larger; single anterior subocular; upper labials 8 (92.8%, N = 7) or 7; lower labials 6, postmental contacting first two labials each side; ear opening large and vertically elliptical with 4 (71.4%, N = 7) or 3 greyish, obtuse to squarish, enlarged lobules anteriorly, forming near continuous free edge.

Scales in 28-32 ($\bar{x}$ = 29.8, SD = 1.2, N = 7) rows at midbody. Dorsal scales smooth, only slightly larger than adjacent lateral scales; paravertebrals 53-55 ($\bar{x}$ = 53.5, SD = 1.0, N = 7), from first scale behind parietals to a point opposite preanal scales. Lamellae beneath fourth toe 24-28 ($\bar{x}$ = 25.6, SD = 1.0, N = 7), pale with moderate (distally) to broad (proximally) dark calli.

Colour and pattern in alcohol: dorsal surface immaculate brown. Broad white dorsolateral stripe from just above eye, posteriorly to just beyond hindlimbs, becoming duller down tail. White dorsolateral stripe bordered above by black laterodorsal stripe to level of hindlimbs, broadest anteriorly.

Upper lateral zone black with up to four pale spots medially situated in forelimb region, becoming grey-brown wash over face. White midlateral stripe from ear opening, posteriorly, to well down tail, most prominent between limbs and along basal part of tail, less well defined anterior to forelimb. Pale midlateral stripe continues along hindlimb but discontinuous with pale midlateral stripe on tail. Midlateral stripe on body bordered below by a dark suffusion giving way anteriorly to mottled grey and black. Hindlimbs with broad, longitudinally aligned, alternate dark and light stripes. Ventrally white.

Colour and pattern in life: as above but bright yellow ventrally from throat, adjacent to level of ear opening posteriorly, to basal part of tail; limbs paler yellow below.

Etymology. This species is named after Dr H.G. Cogger, Deputy Director of the Australian Museum, in recognition of his contributions to our knowledge of the

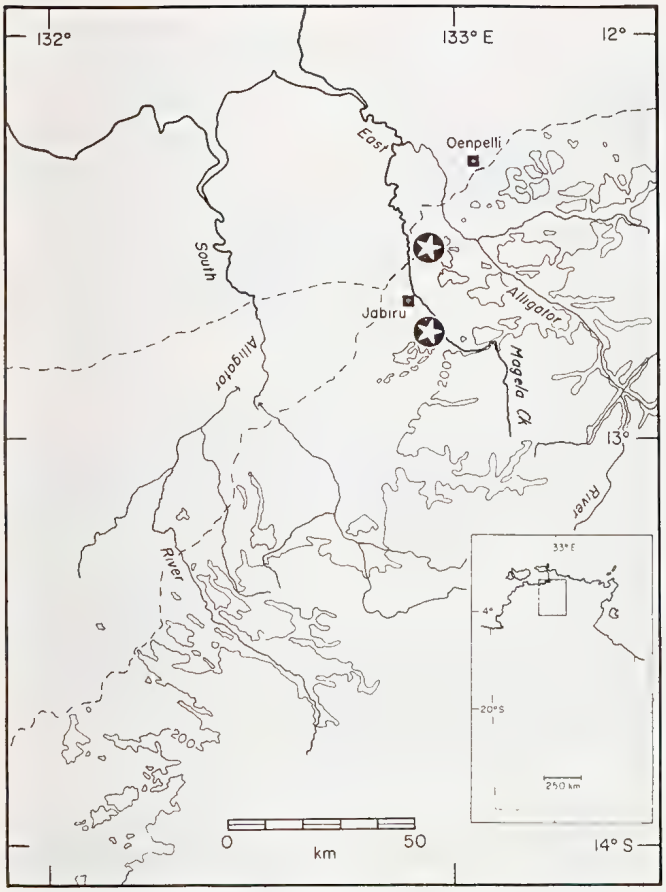

Fig. 3. Map showing the distribution of *Ctenotus coggeri* (light star in closed circle) in the Alligator Rivers region.

northern Australian herpetofauna, particulary in western Arnhem Land.

Distribution. *Ctenotus coggeri* is currently known from the sandstone outliers of Djawamba massif and Mt Brockman on Magela Creek, a tributary of East Alligator River (Fig. 3). I have also observed this species in sandstone woodland on the Mann River (12°31'S x 134°06'E) some 135 kilometres to the east of the type locality.

Habitat. The habitat in which specimens have been collected or observed is sandstone woodland. Detailed description of habitat types and distribution in the Jabiluka area are available in Burgman and Thompson (1982).

Sandstone woodland can broadly be described as communities restricted to rocky slopes, and bluffs of outcropping sandstone. On the bluffs, terrain is rugged with numerous large boulders. Dominant tree species are *Terminalia carpentariae* and *Eucalyptus kombolgiensis*, frequently with a well developed understory of grasses. On the slopes, boulders are smaller and rock piles frequent. Dominant tree species are *E. bleeseri* and *E. miniata* to 16 metres, *E. tetrodonta*, *Xanthostemon paradoxus* and *Terminalia carpentariae*. Shrub understory is frequently present and grass well developed but restricted to rock crevices.

Habits. *Ctenotus coggeri* was collected in pitfall or small mammal traps set overnight and collected in the first dawn hours; it was also observed active during the very early morning hours (0800–1000 hours) amongst sandstone boulders on the slopes of Djawamba massif. In this habitat of sandstone woodland *C. coggeri* is sympatric with *C. inornatus*.

Females from the type series collected August to September 1979 and late February to early March 1973 were reproductively inactive.

Comments. Previously, *C. coggeri* has been confused with *C. inornatus* (Cogger, 1979, Fig. 533), a highly variable species that occurs across northern Western Australia and Northern Territory. In Arnhem Land two distinct forms of *C. inornatus* are recognised, differing by the presence or absence of a prominent white edged dark vertebral stripe.

Only on Centre Island in the Sir Edward Pellew Islands do both forms of *C. inornatus* occur, although the pattern of local distribution on this island is unknown. Specimens from Groote Eylandt, Cape Arnhem, Black Craggy and Centre Islands (of the Sir Edward Pellew Islands) are weakly patterned with the dark vertebral stripe either absent, restricted to the nape or, if present, rarely pale edged, and the pale dorsolateral stripe poorly to strongly dark edged above. Specimens from the McArthur River drainage, East Alligator River drainage, and West and Centre Islands of the Sir Edward Pellew Islands, are strongly patterned with a prominent pale edged dark vertebral stripe and a well developed pale dorsolateral stripe dark edged above. Individuals from west Arnhem Land collected August - September 1978 variably showed a ventral colouration in life that was yellow posterior of the throat and pink anteriorly. A similar pink flush is also apparent in a colour transparency taken by H.G. Cogger (Australian Museum) of a specimen from Centre Island. Specimens showing this ventral coloration were only collected from sandstone escarpment or outcroppings.

In western Arnhem Land, *C. coggeri* occurs sympatrically with the strongly patterned form of *C. inornatus* in sandstone woodland habitats. Here *C. coggeri* can be most readily distinguished by a colour pattern featuring a uniform dorsal surface (vs presence of a dark, white edged vertebral stripe in *C. inornatus*) and a pale midlateral stripe continuous onto the hindlimb (vs pale midlateral stripe passing over the hindlimb and continuing along the tail in *C. inornatus*). A combination of scalation characteristics provided in the diagnosis further serve to distinguish *C. coggeri* from the strongly patterned form of *C. inornatus*.

The type of *Hinulia inornata* Gray (= *Ctenotus inornatus*) (Figs 4, 5) most closely resembles individuals of *C. inornatus*, from Cape Arnhem and Groote Eylandt, lacking a dark vertebral stripe. *Ctenotus coggeri* is distinguished in colouration from the type of *H. inornata* and the poorly patterned form of *C. inornatus* by the same features of the pale midlateral striping described above and by the features in scalation provided in the diagnosis.

The type of *Hinulia inornata* in the British Museum

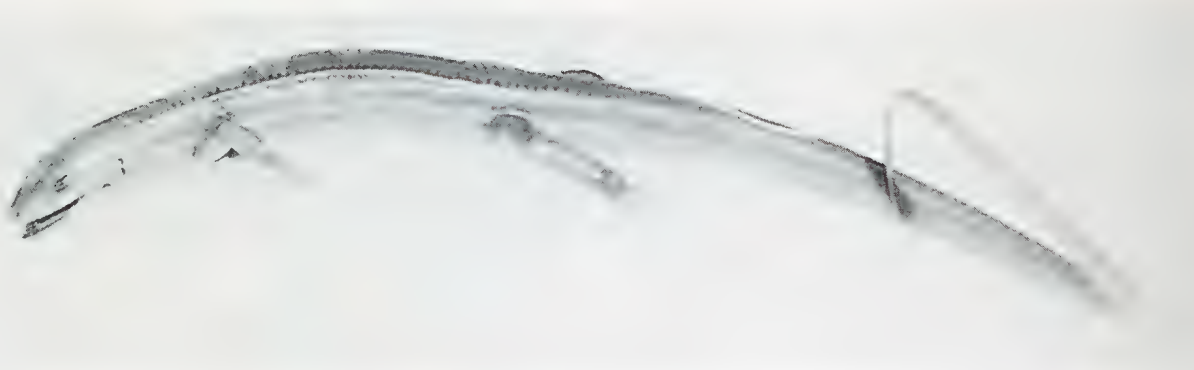

Fig. 4. Holotype of *Hinulia inornata* (BM.1946.8.15.45).

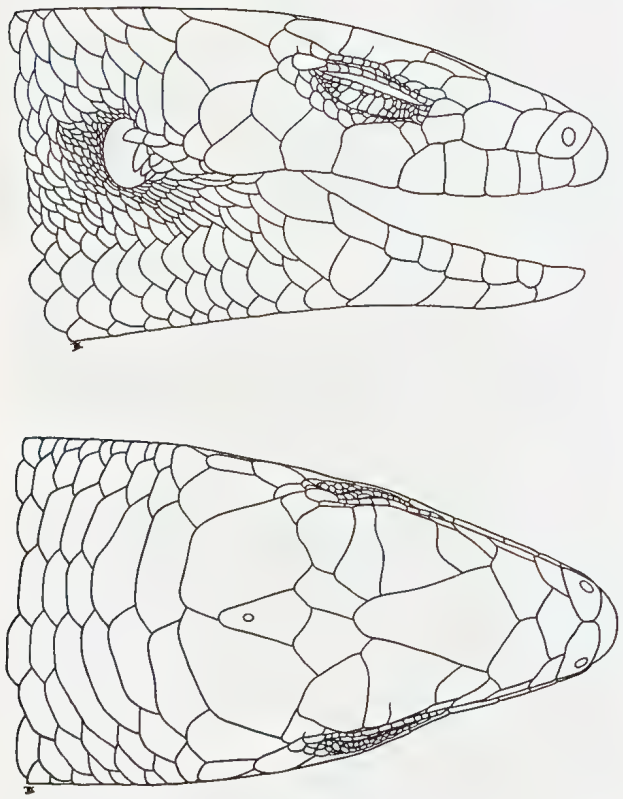

Fig. 5. Lateral and dorsal views of the head of the type of *Hinulia inornata* (BM.1946.8.15.45.).

(Natural History) (BMNH 1946.8.15.45) is erroneously listed in the catalogue as from 'Swan River'. Storr (1975) recognised the doubtful nature of the type locality and indicated it to probably be in error for Port Essington, Northern Terrirtory. However, survey work by Cogger & Lindner (1974) and subsequent years of collecting by Lindner on Coburg Peninsula, where Port Essington is located, have not produced specimens of *C. inornatus*.

ACKNOWLEDGEMENTS. I thank Professor G.B. Sharman of Macquarie University for the opportunity to do field work in the region, Mike Fleming and Anne Kerle for help in collecting specimens, and Pan Continental Mining Company for providing funds, accommodation and facilities during the period of field work. Specimens were collected under permits issued by the Conservation Commission for the Northern Territory and the Australian National Parks and Wildlife Service; their cooperation was appreciated. Dr E.N. Arnold of the British Museum (Natural History) kindly lent the holotype of *Hinulia inornata*. The following people reviewed the manuscript at various stages: Dr H.G. Cogger, Dr A. Greer, Dr J. Paxton, Mr G. Shea, Dr G. Storr and Mr J. Wombey; I am grateful to them for their comments and advice. Artwork for figures 2 and 5 were prepared by Debbie Kent, and for figure 3 by Phlyp Greer.

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RECORDS
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VOLUME 36 No. 4

Two new species of *Cerapus* from Samoa and Fiji (Crustacea: Amphipoda: Ischyroceridae) ..... J.K. LOWRY Page 157

A review of the genus *Parioglossus* with descriptions of six new species ..... DENISE S. RENNIS & DOUGLASS F. HOESE Page 169

Two new species of *Cerapus* from Samoa and Fiji (Crustacea: Amphipoda: Ischyroceridae).

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Abstract. *Cerapus oceanicus* and *C. pacificus* are described from Samoa and Fiji. They are distinguished from other species in the *Cerapus* group mainly on the morphology of the second gnathopods. A discussion of genera in the *Cerapus* group indicates that *Runanga* and *Baracuma* may be based on gradational characters.

Lowry, J.K., 1985. Two new species of *Cerapus* from Samoa and Fiji (Crustacea: Amphipoda: Ischyroceridae). Records of the Australian Museum 36: 157-168.

Keywords: Amphipoda, Ischyroceridae, *Cerapus*, west-Pacific, taxonomy.

There are now three closely related genera in the *Cerapus* group: *Cerapus* Say (1817), *Runanga* Barnard (1961) and *Baracuma* Barnard & Drummond (1982). These genera are extremely similar in morphology and share several highly apomorphic characters, particularly peraeopod 5, uropods 1 to 3 and the telson. As Barnard & Drummond (1982) pointed out, an unequivocal diagnosis of *Cerapus* is difficult because the type specimen of *C. tubularis* Say (type-species of the genus) is lost. *Runanga* was established for species with a scale-like accessory flagellum and progressively reduced pleopods. The male has never been described. *Baracuma* was established for species with irregularly shaped coxae 1 to 4, apically narrowed and poorly cleft telson, an elongate fifth peraeonite and coxa in adult females and a ventral keel on peraeonite 2 in adult males.

Some of the characters used to distinguish *Runanga* and *Baracuma* appear to be gradational. The elongation of the fifth peraeonite and coxa in adult females also occurs in *Runanga coxalis* Barnard, *Cerapus benthophilis* Thomas & Heard, and both species described here. The shape of the telson in *C. benthophilus* and *B. alquirta* Barnard & Drummond is very similar, but the cleft is deeper in *C. benthophilus*. In the new species described here both have apically narrowed telsons but one is notched and the other is cleft to the base. All of these species have some degree of progressively reduced pleopods and all have some degree of irregularly shaped coxae 1 to 4. The peculiar antennal character mentioned by Barnard & Drummond (1982) to distinguish *C. crassicornis* Bate from *Baracuma* helps to define a coldwater group of *Cerapus* species discussed by Lowry (1981).

Runanga is thus distinguished by its vestigial accessory flagellum and *Baracuma* by the ventral keel on peraeonite 2 of the adult male. The new species described here have neither of these characters. I am therefore placing them in the broadly defined genus *Cerapus*. There are many *Cerapus*-like species in the South Pacific and Indian Oceans awaiting description. Their description will probably help to make generic definitions much clearer.

Cerapus oceanicus n.sp.

Figs 1–5

Type material. Holotype, male, 6.1 mm AM P34734; allotype, 5.3 mm, AM P34735; 13 males, 15 females and juvenile paratypes AM P34736-P34740; Apia, Upolu, Western Samoa, 13°48'S 171°44'W, collected in the lagoon, living on the seagrass, *Halodule* sp., 0.5 m depth, A.A. Myers.

Diagnosis. Rostrum acute, ⅓ length of peduncular article 1. Gnathopod 2 of adult male, palm of article 5 with an inner tooth, article 5 twice as long as broad and slightly expanded posterodistally, dactyl crenulate along posterior margin. Coxa 3 with sinusoid anteroventral margin. Coxa 4 with a subquadrate lobe anteriorly. Peraeopod 4, article 2 as long as articles 3 to 7 combined. Peraeopod 6, setae on posterodistal corner of article 5 longer than articles 6 and 7 combined. Peraeopod 7, elongate setae on antero- and posterodistal corners of article 5. Telson cleft to base.

Description. Holotype male, 6.1 mm. *Head*: rostrum acute, elongate, about ⅓ length of peduncular article 1; lateral cephalic lobes with subacute anteroventral corners. Body elongate, cylindrical, mottled brown throughout, peraeonites 5 and 6 longest, subequal in length.

Antenna 1 well developed, setose, about ½ length of body; peduncular articles 1 and 2 subequal in length and slightly shorter than article 3, article 1 expanded

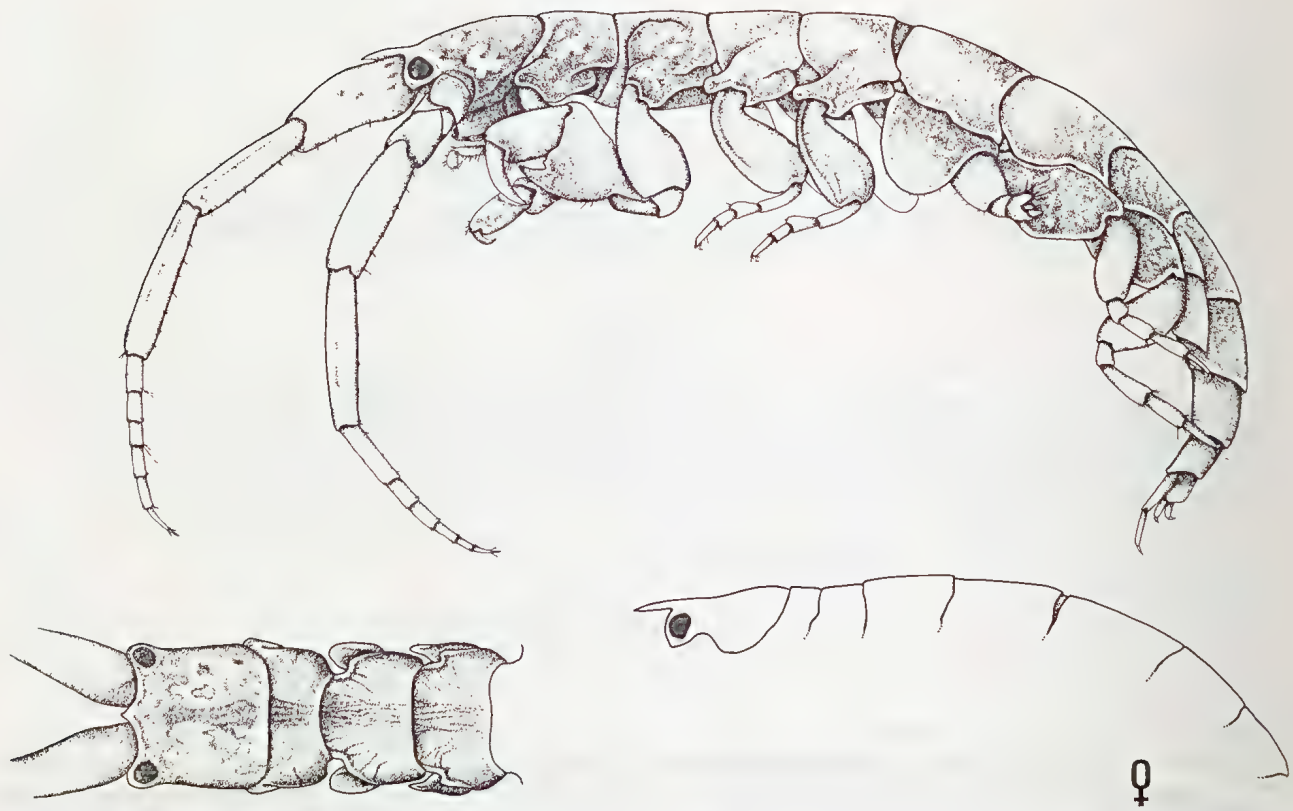

Fig. 1. *Cerapus oceanicus* n.sp., paratype, male, 6.8 mm, AM P39736; allotype, female, 5.3 mm, AM P34735; Apia, Upolu, Western Samoa.

posteroproximally; flagellum nearly ⅓ length of peduncle, 7-articulate, seventh article with 2 strong spines. *Antenna 2* well developed, setose, slightly longer than antenna 1, fifth peduncular article longer than fourth; flagellum 4-articulate, nearly ⅓ length of peduncle, article 1 about as long as following 3 articles combined, ultimate article with 2 well developed spines.

Mandible: incisor with 6 teeth; lacinia mobilis multidentate and curved back over itself; 3 accessory spines present; molar triturating, molar flake present; palp elongate, slender, article 2 slightly longer than article 3 with 3 median setae and 1 lateral seta, article 3 with about 15 medial to apical setae. *Maxilla 1*: inner plate not known; outer plate with 10 spine-teeth; palp with 6 apical spines and 5 subapical setae. *Maxilla 2*: outer plate broader than inner plate, both apically setose and inner plate with setae along medial margin. *Maxilliped*: inner plate subquadrate with 3 stout terminal spines and plumose setae along medial and terminal margins; outer plate with 10 strong teeth along medial margin and 3 stout apical setae; palp article 2 longest with a clump of distomedial setae, article 3 setose distally, article 4 with strong terminal spine.

Gnathopod 1 subchelate; article 5 with lobate posterior margin bearing setae; article 6 about 1.5 times as long as broad, anterior margin with 5 rows of setae, palm extremely oblique, setose; dactyl well developed, closing along entire palm. *Gnathopod 2* carpochelate; article 5 extremely enlarged, triangular in shape and nearly 2.5 times as long as broad, posterodistal margin setose, palm with a large outer tooth and a smaller inner tooth; article 6 twice as long as wide, slightly expanded posterodistally; dactyl nearly as long as article 6, setose along crenulate posterior margin and closing along entire margin of large outer tooth of article 5.

Peraeopod 3: coxa 3 times as broad as deep, anteroventral margin sinusoid; article 2 about 1.8 times as long as broad and about as long as articles 3 to 7 combined. *Peraeopod 4* similar to peraeopod 3 except coxa about twice as broad as deep and anteroventral margin forming a subquadrate lobe. *Peraeopod 5* short, stout; coxa about 1.3 times as broad as deep, with a large anteroventral lobe and a small posteroventral lobe; article 2 about as broad as long; article 4, posterior lobe with 6 long plumose setae and several short setae; article 5 smaller than article 4, posterior lobe covered in minute denticles and 1 plumose seta; dactyl uncinate with 1 large recurved spine and 2 small recurved spines. *Peraeopod 6* slender, slightly longer than peraeopod 5; article 5 with a group of long posterodistal setae; dactyl uncinate with 1 large and 2 small recurved spines. *Peraeopod 7* similar to peraeopod 6 except article 5 with anterodistal and posterodistal clumps of long setae.

Pleopods 1 – 3 decreasing in size. Pleopod 3 with inner ramus small, about ½ length of outer ramus. *Uropod 1* biramous; peduncle slightly more than 3 times as long as broad with a fan of short spines along distal margin; outer ramus ¾ length of peduncle, lateral

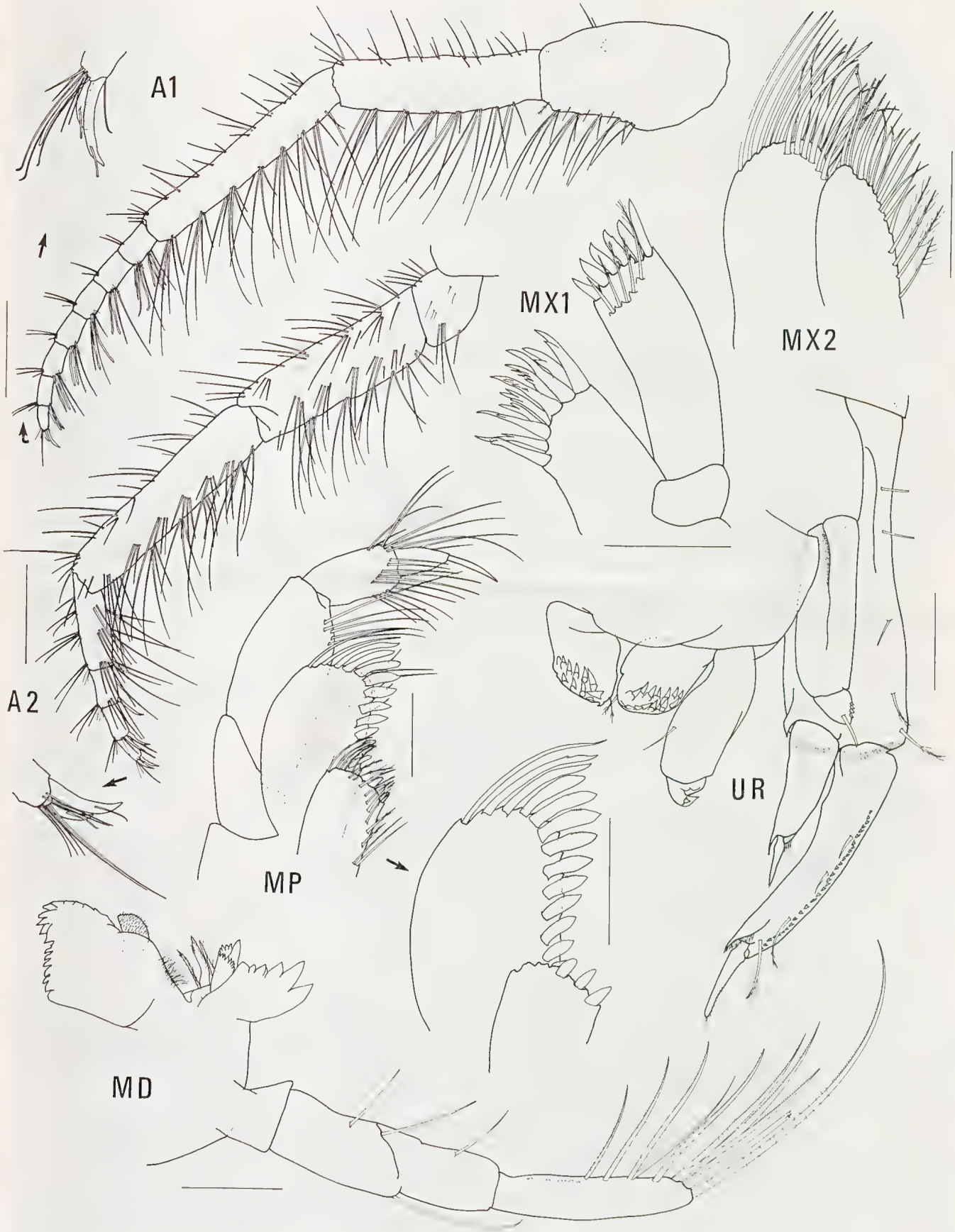

Fig. 2. *Cerapus oceanicus* n.sp., holotype, male, 6.1 mm, AM P34734; Apia, Upolu, Western Samoa. Scales represent 0.1 mm.

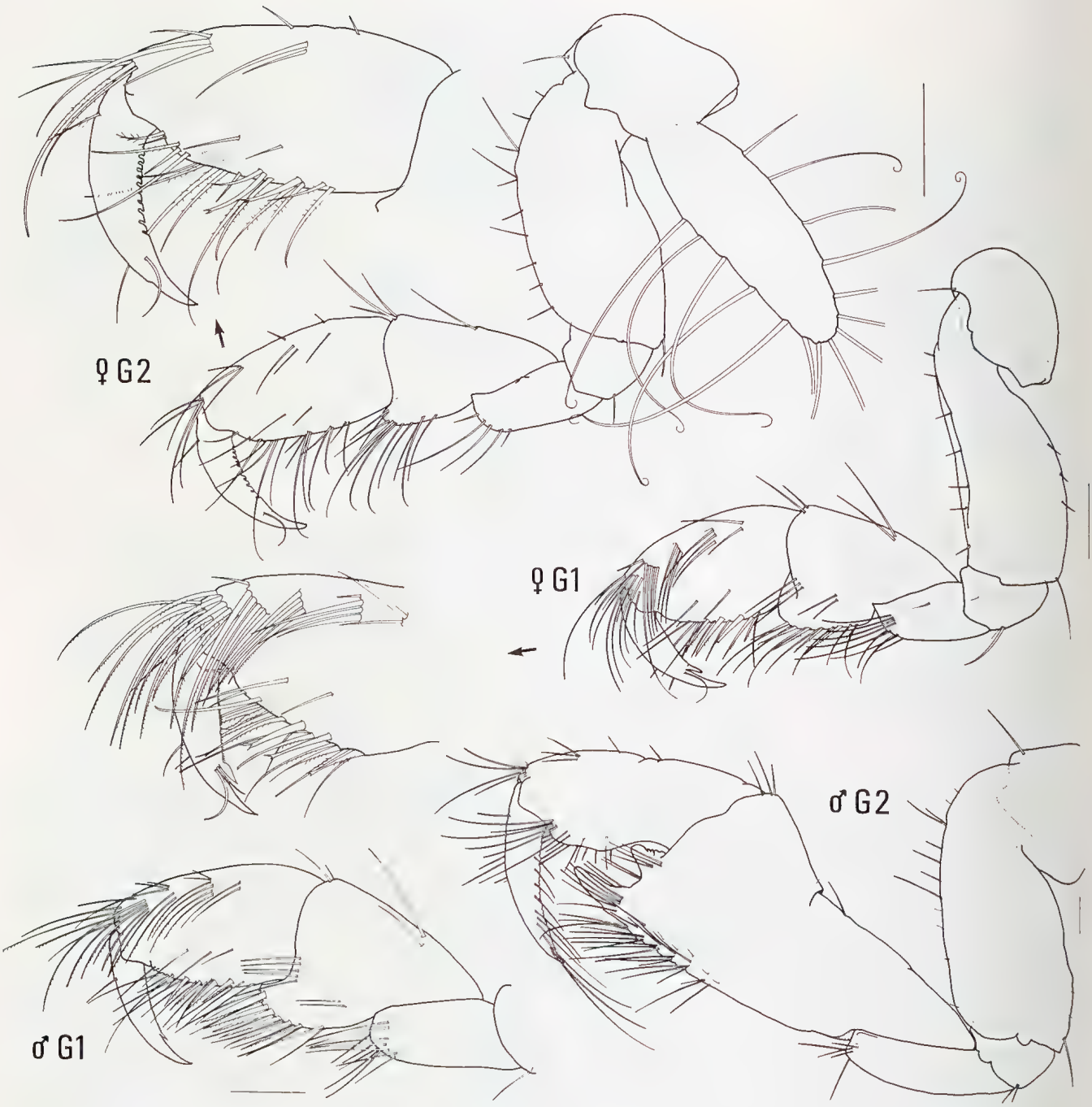

Fig. 3. *Cerapus oceanicus* n.sp., holotype, male, 6.1 mm, AM P34734; allotype, 5.3 mm, AM P34735; Apia, Upolu, Western Samoa. Scales represent 0.1 mm.

margin with a row of minute denticles and short setae and a large terminal spine partially surrounded by a collar of short spines; inner ramus nearly ½ length of outer ramus with a collar of short spines partially surrounding large terminal spine. *Uropod 2* uniramous, extending to distal margin of the peduncle of uropod 1; ramus very small, with a small patch of minute lateral spines and a small terminal seta. *Uropod 3* uniramous; peduncle 2.5 times as long as broad; ramus very small, biuncinate. *Telson* completely cleft, each lobe with 2 rows of 7 recurved spines.

Female paratype 5.3 mm. Similar to male except in the following ways. Gnathopod 2 subchelate, slightly larger than gnathopod 1; article 5 smaller than article 6, posteriorly lobate, setose; article 6 twice as long as broad, palm setose, extremely oblique; dactyl well developed, posterior margin crenulate.

Juvenile males 5.0 mm in length already have article 5 of gnathopod 2 enlarged, but only slightly longer than broad and the inner tooth of the palm is present. A juvenile 6.0 mm long has article 5 nearly 1.5 times as long as broad and the inner tooth of the palm is slightly better developed. In adults 6.1 mm long article 5 has become nearly 2.5 times as long as broad and the inner

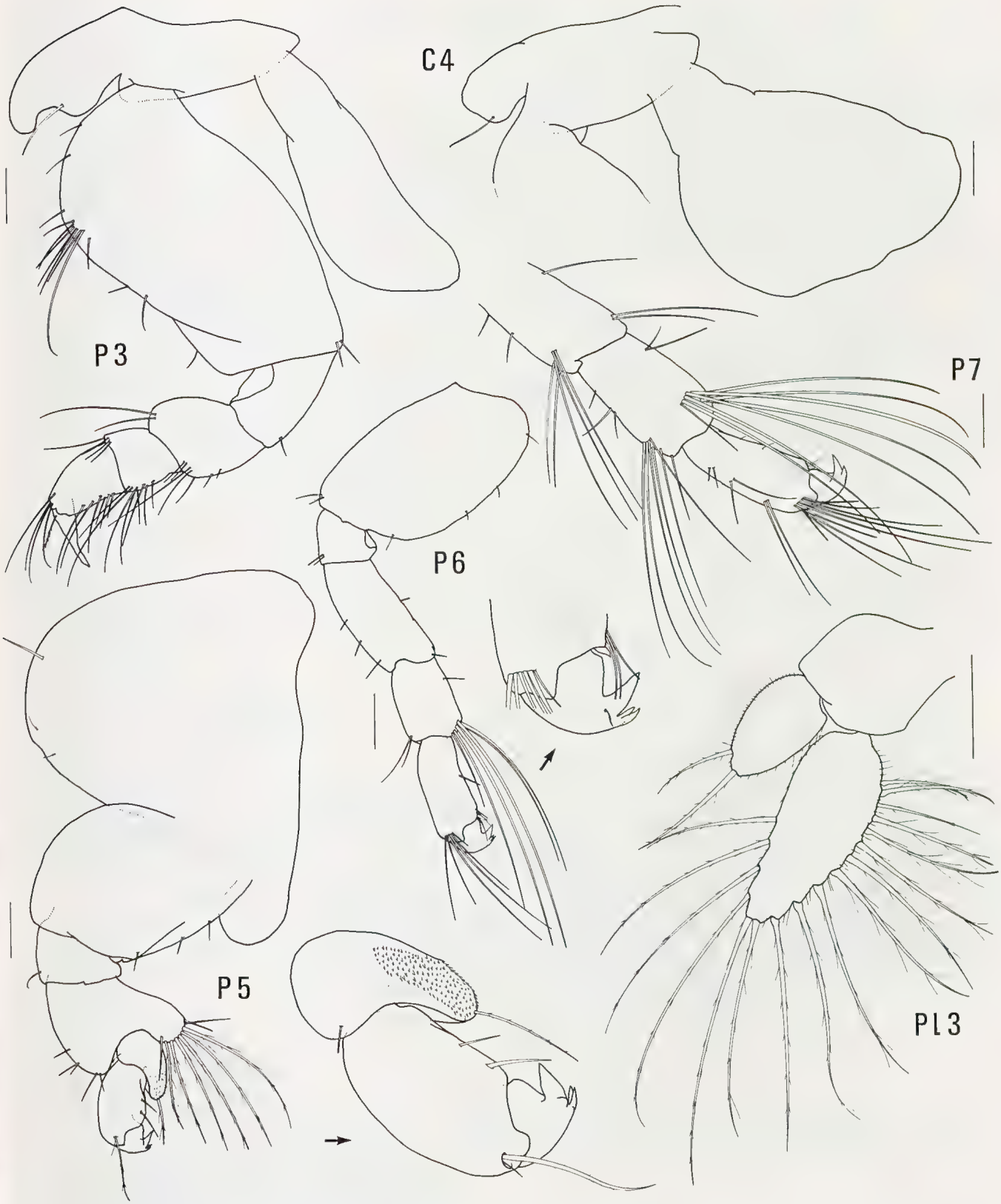

Fig. 4. *Cerapus oceanicus* n.sp., holotype, male, 6.1 mm, AM P34734; Apia, Upolu, Western Samoa. Scales represent 0.1 mm.

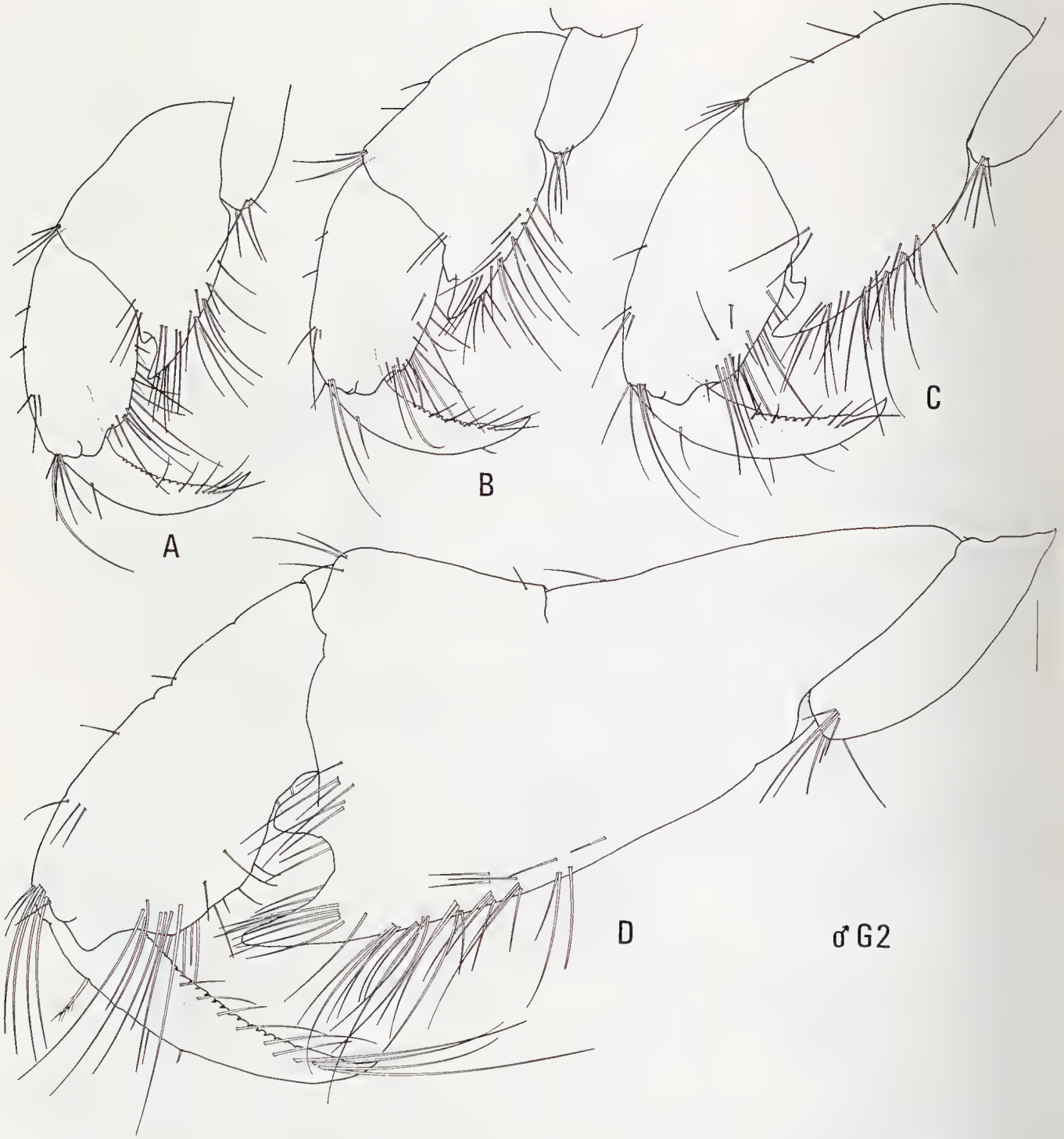

Fig. 5. *Cerapus oceanicus* n.sp.; **A,** paratype, male, 5.0 mm, AM P34737; **B,** paratype, male, 5.3 mm, AM P34738; **C,** paratype, male, 6.0 mm, AM P34737; **D,** holotype, male, 6.1 mm, AM P34734.

tooth of the palm is well developed. In this species the development of gnathopod 2 is not complicated. As it increases in size the only allometric growth occurs in the elongation of article 5.

Remarks. *Cerapus oceanicus* differs from all described species in having the telson cleft to the base. It is very similar to *C. calamicola* (Giles, 1885) in the shape of gnathopod 2 in the mature male. Both species have an extremely long carpus with a well developed inner tooth on the palm, both have a short broad propodus which is expanded distally and both have a crenulate posterior margin on the dactyl. But *C. calamicola* has a very short, blunt rostrum, a shallow cleft on the telson, different length ratios between articles 2 and 3 of the mandibular palp, and setae all along the posterior margin of the carpus of gnathopod 2. In Giles' (1885) drawing of the whole animal, peraeopods 6 and 7 appear to be quite large. *Cerapus oceanicus* is easily distinguished from *C. pacificus* by gnathopod 2 which does not have an inner tooth on the palm and which has a long slender propodus. In addition, the rostrum of *C. pacificus* is very short, the telson has a shallow cleft and the antennae are more slender. *Baracuma alquirta* Barnard & Drummond is distinguished from *C. oceanicus* by its short rostrum, shallow cleft telson and small second articles on peraeopod 4.

Cerapus oceanicus is currently known only from the Samoan Islands living on the seagrass, *Halodule* sp., on shallow reef flats.

Cerapus pacificus n.sp.

Figs 6–10

Type material. HOLOTYPE, male, 6.2 mm, AM P34724; allotype, 5.5 mm, AM P34725; 8 males, 20 females and juvenile paratypes AM P34726-P34733; Nasese, Viti Levu, Fiji, 16°33'S 179°47'E, collected by A.A. Myers, 7 September 1979, from the reef flat, living on the seagrass *Syringodium isoetifolium*.

Diagnosis. Rostrum acute, very short, length of peduncular article 1. Gnathopod 2 of adult male, palm of article 5 lacking inner tooth; article 5, 5 times as long as broad, dactyl not crenulate along posterior margin. Coxae 3 and 4 with produced subquadrate anterior lobe. Peraeopod 4, article 2 as long as articles 3 to 7 combined. Peraeopod 6, setae on posteroventral corner of article 5 slightly longer than articles 6 and 7 combined. Peraeopod 7, elongate setae on antero- and posterodistal corners of article 5. Telson cleft about ¼ length.

Description. Holotype male, 6.2 mm long. *Head*: rostrum acute, very short; lateral cephalic lobe with anteroventral corner rounded. Body elongate, cylindrical, head and peraeonite 1 mottled brown; peraeonite 2 in adult male longest segment, in adult female peraeonite 5 longest segment.

Antenna 1 well developed, setose, about slightly more than half body length; peduncular articles 2 and 3 subequal in length and slightly longer than article 1; article 1 expanded posterodistally; flagellum ½ length of peduncle, with 5 articles, fourth and fifth articles with stray spines. *Antenna 2* well developed and slightly longer than antenna 1, fifth peduncular article longer than fourth; flagellum 5-articulate, nearly ½ length of peduncle, article 1 as long as remaining articles; penultimate article with a long and a short strong spine, ultimate article vestigial.

Mandible: incisor with 5 teeth; lacinia mobilis multidentate and curved back over itself; 4 accessory spines present; molar triturating, molar flake absent; palp elongate, slender, article 2 slightly shorter than article 3 with at least 5 medial setae, article 3 with about 18 medial to apical setae. *Maxilla 1*: inner plate not known; outer plate with 9 spine-teeth; palp with 7 apical spines and 5 subapical setae. *Maxilla 2*: outer plate

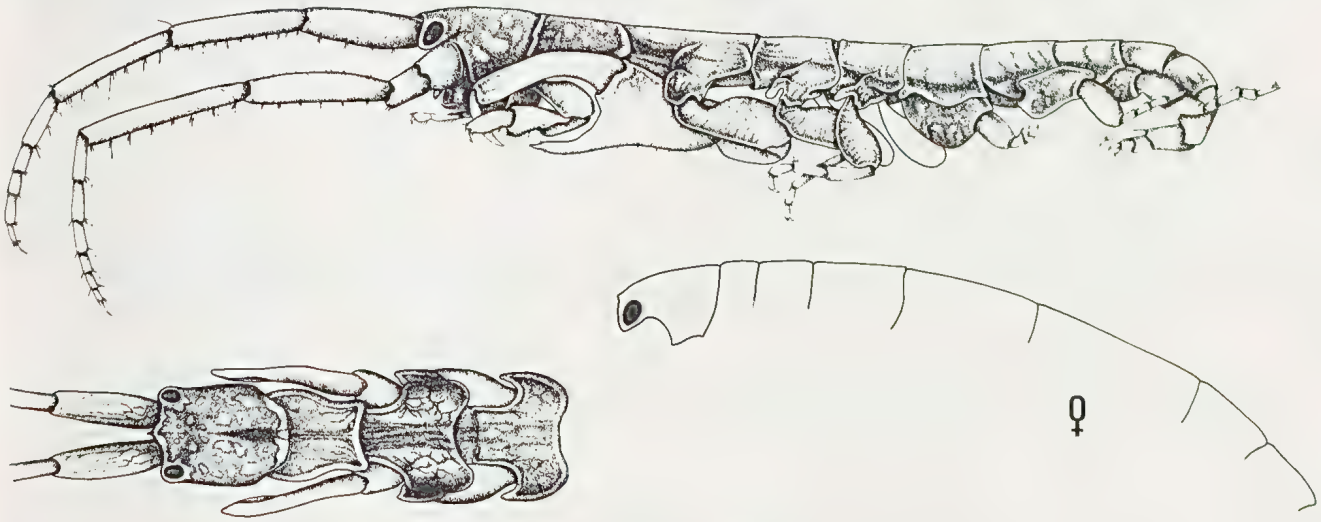

Fig. 6. *Cerapus pacificus* n.sp., paratype, male, 6.2 mm, AM P34726; allotype, female, 5.5 mm, AM P34725; Nasese, Viti Levu, Fiji.

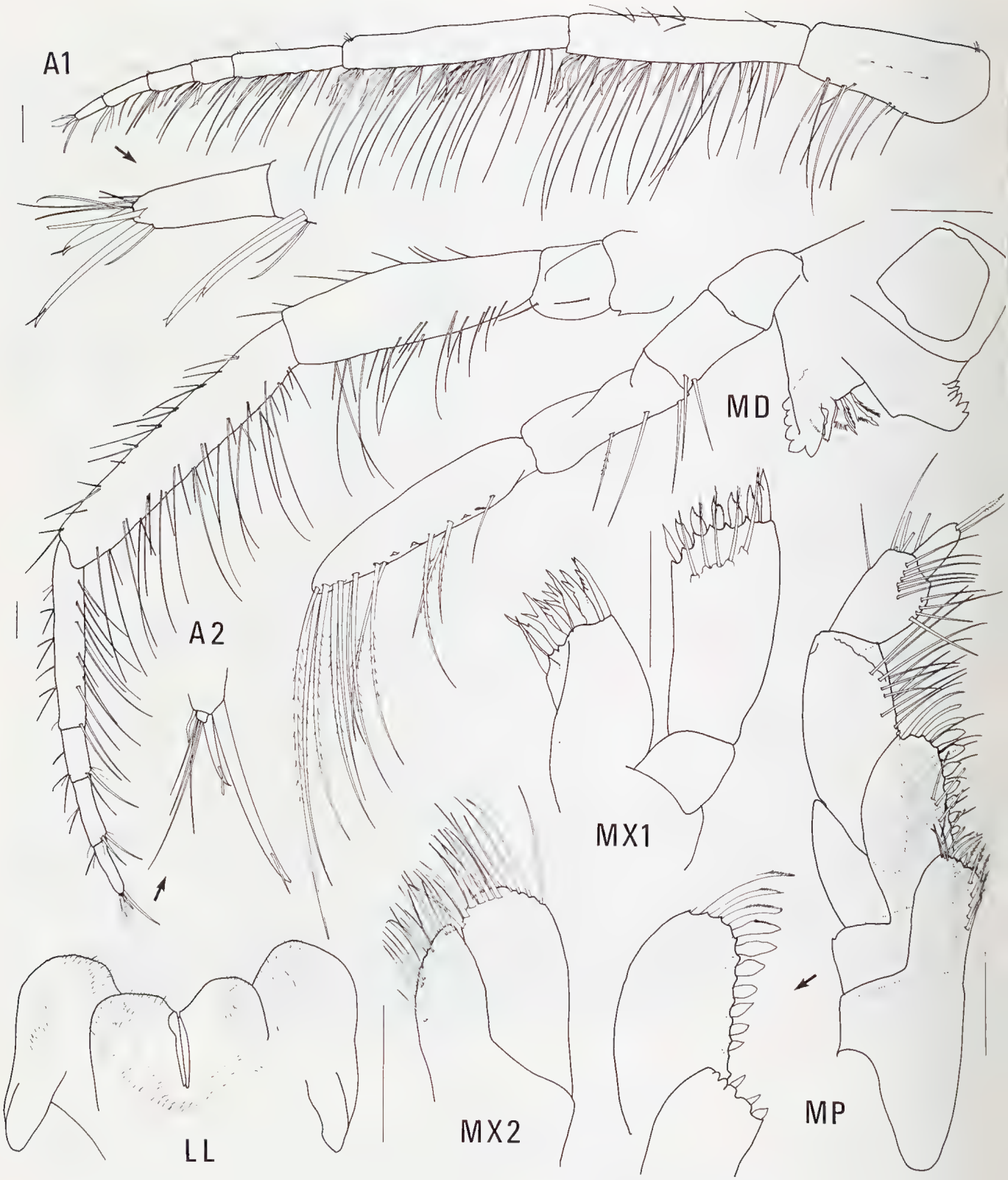

Fig. 7. *Cerapus pacificus* n.sp., holotype, male, 6.2 mm, AM P34724; Nasese, Viti Levu, Fiji. Scales represent 0.1 mm.

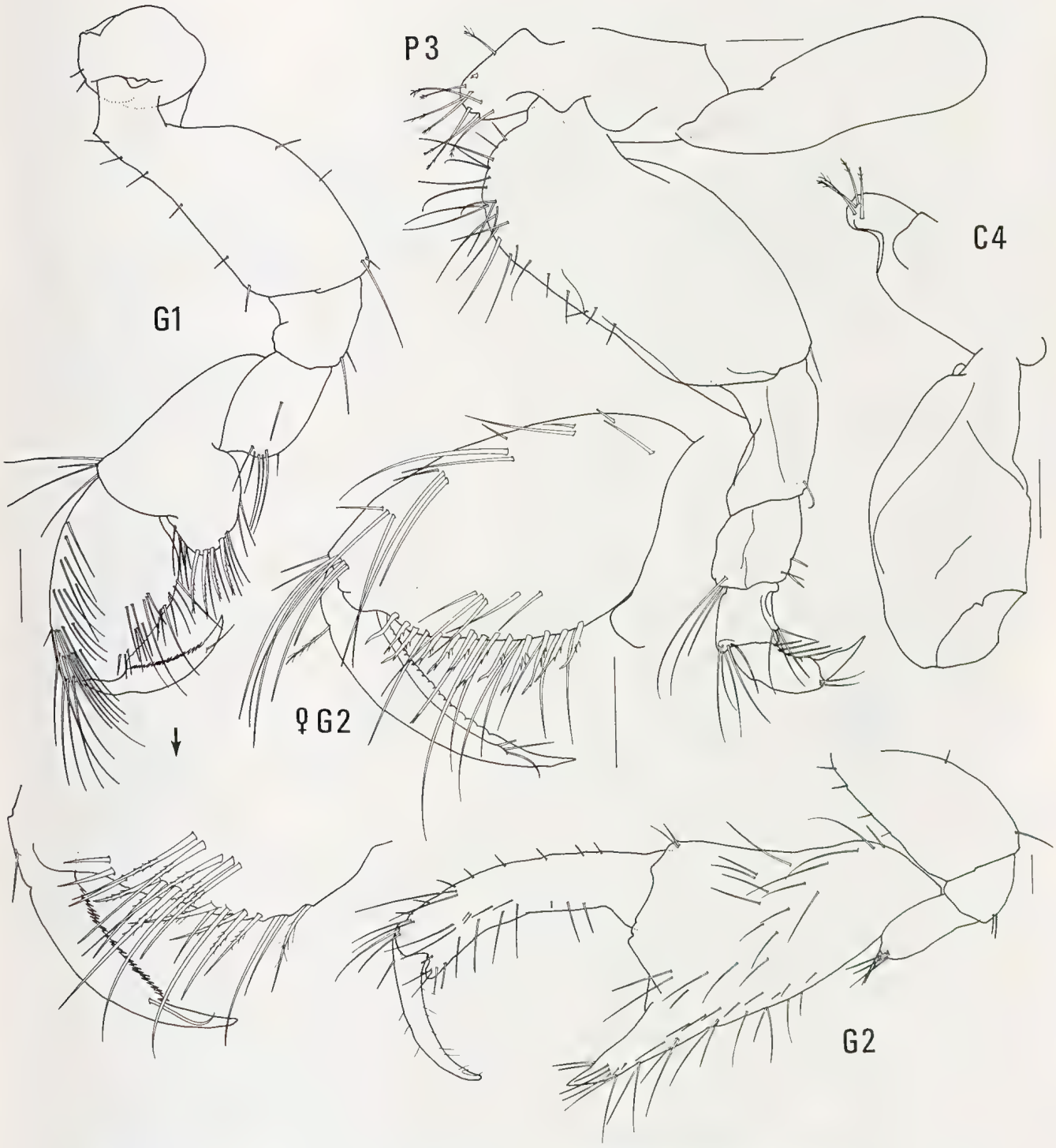

Fig. 8. *Cerapus pacificus* n.sp., holotype, male, 6.2 mm, AM P34724; allotype, 5.5 mm, AM P34725; Nasese, Viti Levu, Fiji. Scales represent 0.1 mm.

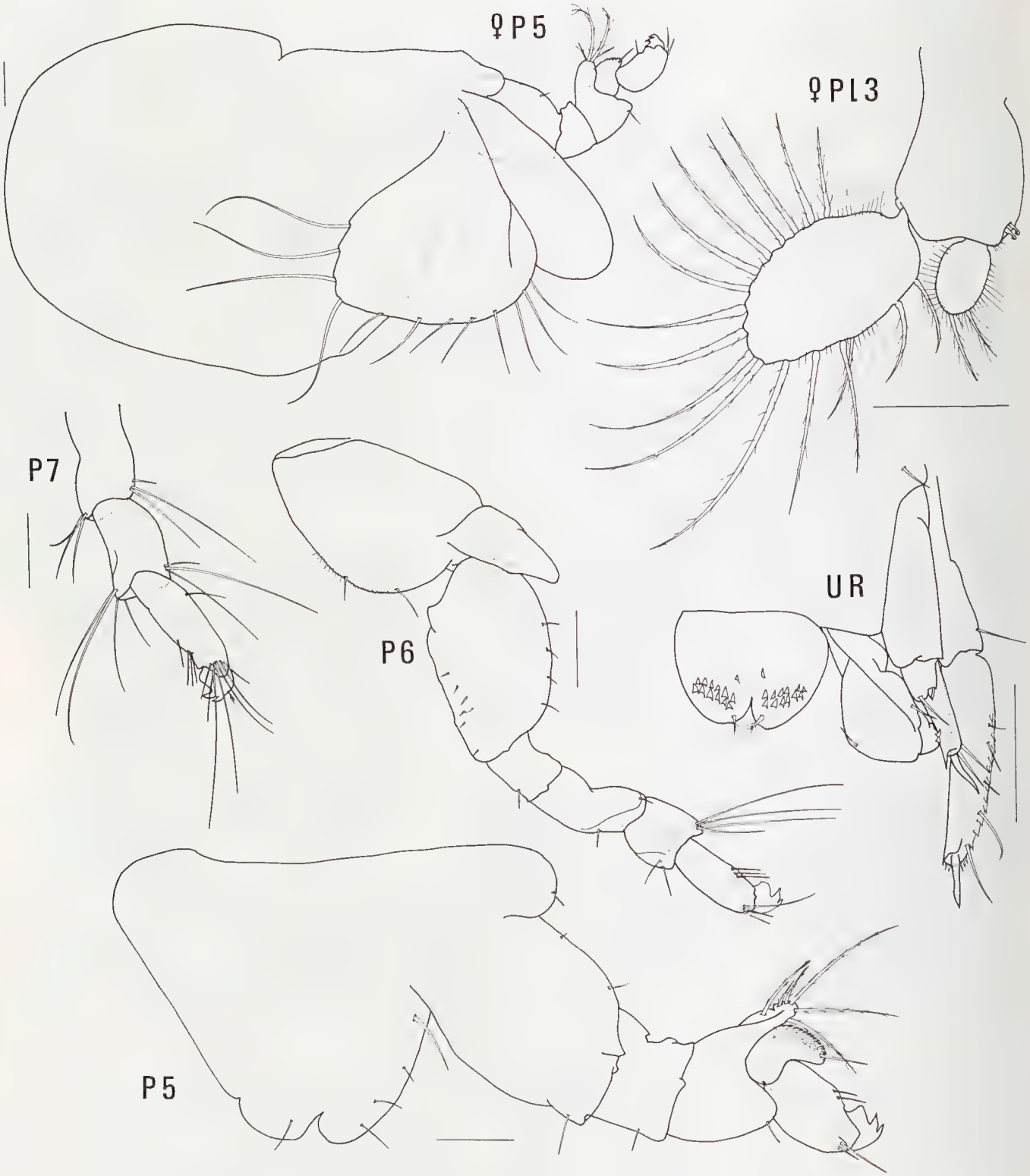

Fig. 9. *Cerapus pacificus* n.sp., holotype, male, 6.2 mm, AM P34724; allotype, 5.5 mm, AM P34725; Nasese, Viti Levu, Fiji. Scales represent 0.1 mm.

Fig. 10. *Cerapus pacificus* n.sp.; **A,** paratype, male, 3.5 mm, AM P34727; **B,** paratype, male, 4.1 mm, AM P34728; **C,** paratype male, 4.4 mm, AM P34729; **D,** paratype, male, 4.9 mm, AM P34730; **E,** paratype, male, 5.0 mm, AM P34731; **F,** paratype male, 5.2 mm, AM P34732; Nasese, Viti Levu, Fiji. Scale represents 0.1 mm.

broader than inner plate, both apically setose and inner plate setose along medial margin. *Maxilliped*: inner plate subquadrate with 3 stout spines and plumose setae along medial and terminal margins; outer plate with 8 strong teeth along medial margin and 2 stout apical setae; palp article 2 longest with a row of distomedial setae, article 3 setose distally, article 4 with a slender terminal spine.

Gnathopod 1 subchelate, article 5 with lobate posterior margin bearing setae; article 6, 1.5 times as long as broad, anterior margin with 6 rows of setae; palm oblique, setose; dactyl well developed, closing along entire palm. *Gnathopod 2* carpochelate; article 4 extremely enlarged, triangular in shape and twice as long as broad, posterior margin sparsely setose, palm with large outer tooth, inner tooth lacking; article 6, 5 times as long as broad; dactyl slightly more than half length of article 6, sparsely setose along posterior margin.

Peraeopod 3: coxa 2.25 times as broad as deep, forming a subquadrate lobe anteriorly; article 2 about 2.1 times as long as broad and slightly less than the length of articles 3 to 7 combined. *Peraeopod 4* similar to peraeopod 3 except coxa about 2.75 times as broad as deep and anterior lobe rounded. *Peraeopod 5* short, stout; coxa subtriangular in shape and 1.5 times as broad as deep with a large anteroventral lobe and a small posterior lobe; article 2 nearly 1.4 times as long as broad; article 4, posterior lobe with 3 long and 3 short plumose setae; article 5 smaller than article 4, posterior lobe covered in minute denticles and one seta; dactyl uncinate, with 2 recurved teeth. *Peraeopod 6* slender, about as long as peraeopod 5; article 5 with a group of long posterodistal setae; dactyl uncinate with 2 small recurved teeth. *Peraeopod 7* similar to peraeopod 6 except article 5 with anterodistal and posterodistal clumps of long setae.

Pleopods 1 – 3 decreasing in size, pleopod 3 with inner ramus small, 0.37 times length of outer ramus. *Uropod 1* biramous; peduncle 2.8 times as long as broad, with a fan of small spines along distal margin; outer ramus 0.8 times as long as peduncle, lateral margin with a row of minute denticles and setae, a large terminal spine partially surrounded by a collar of small spines; inner ramus ½ length of outer ramus. *Uropod 2* uniramous, extending nearly halfway along inner ramus of uropod 1; ramus small with 2 small subterminal spines and 1 terminal seta. *Uropod 3* uniramous; peduncle about 2.5 times as long as broad; ramus very small with 2 minute recurved hooks. *Telson* slightly broader than long, cleft about ¼, each lobe with 2 rows of about 6 recurved spines and a small apical plumose seta.

Female paratype 5.5 mm long. Similar to the male except: gnathopod 2 subchelate; article 5 smaller than article 6; article 6 about 1.5 times as long as broad, palm setose and extremely oblique; dactyl well developed, closing along entire margin of palm, posterior margin slightly crenulate.

In juvenile males 3.5 mm in length the fifth article of gnathopod 2 has begun to broaden and a small palm is evident. In juveniles 4.1 mm long an inner and outer tooth has formed on the palm and the inner tooth remains in individuals up to 5.0 mm long. The outer tooth continues to elongate until in fully grown adult males it is ¾ the length of the dactyl. The propodus continues to lengthen with growth but does not broaden appreciably.

Remarks. *Cerapus pacificus* is easily distinguished from its nearest relatives, *C. calamicola* and *C. oceanicus,* by the lack of an inner tooth on the palm of gnathopod 2 in adult males. This character and the lack of a ventral keel on peraeonite 2 distinguish *C. pacificus* from *Baracuma alquirta*.

Cerapus pacificus is known at present only from the shallow reef flats in Suva Bay, Fiji where it lives among the seagrass, *Syringodium isoetifolium*.

ACKNOWLEDGEMENTS. I thank Dr A.A. Myers, University College, Cork, for donating the material and Sharne Dunlop for her illustrations of the whole animals.

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A Review of the Genus *Parioglossus*, with Descriptions of Six New Species (Pisces: Gobioidei)

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ABSTRACT. Fourteen species of *Parioglossus* are recognized from the warm temperate to tropical western Pacific and Indian Oceans: *P. aporos* n. sp., *P. dotui*, *P. formosus*, *P. lineatus* n. sp., *P. marginalis* n. sp., *P. nudus* n. sp., *P. palustris*, *P. philippinus*, *P. rainfordi*, *P. raoi*, *P. taeniatus*, *P. triquetrus* n. sp., *P. verticalis* n. sp., *P.* sp. Synonymies, general morphology and osteology of the genus are described, and a key for separating the species is included. Diagnoses, descriptions, distributions, comparisons, line drawings and photographs of each species are given as well as synonymies of previously described species. Notes on ecology and food preferences are included when known. Tables of meristics and morphometrics are included for the holotypes and for all other material. Different characteristics of the species are compared in a separate table. Similarities between *Parioglossus* and related genera, in the subfamily Ptereleotrinae, are discussed. Provisionally, the subfamily is placed in the family Microdesmidae.

Rennis, D.S. & D.F. Hoese, 1985. A review of the genus *Parioglossus*, with descriptions of six new species (Pisces: Gobioidei). Records of the Australian Museum 36: 169-201.

Keywords: Gobioidei, *Parioglossus*, taxonomy, Indo-Pacific, coral reefs, mangroves.

The genus *Parioglossus* consists of fourteen species that inhabit warm temperate to tropical regions of the western Pacific and Indian Oceans. These fishes are normally found around the roots of mangroves, or around algae in estuaries and coastal coral reefs. Only a few of the species appear to be widespread, however all the species are small sized (size range of mature fish varies from 17.4 mm for *P. nudus*, to 39 mm for *P. marginalis*) and sampling of their usual habitats is normally avoided by collectors. Our experience and that of V. Springer (*in litt.*) suggest that the fish are difficult to collect in mangroves. When collected with rotenone, the fishes rise to the surface only briefly and then disappear into the muddy waters. It is likely that as tropical mangrove zones are sampled more extensively, the distribution range of many of the species will be found to be greater than now appears. Few of the species occur around coral reefs, which have been sampled more extensively. Presently only *P. philippinus* and *P. taeniatus* are known from the western Indian Ocean to the western Pacific. Several of the species are known to occur in schools. Gut contents indicate that zooplankton, mainly copepods, comprise their diet.

Tomiyama (1958, 1959) reviewed and Senou and Suzuki are revising the *Parioglossus* species of Japan, but there is no comprehensive revision of this genus available. Tomiyama (1958, 1959) was apparently unaware that *Herreolus* and *Andameleotris* are synonyms of *Parioglossus*, and Herre (1945a) ignored species of *Parioglossus*. As a result the same species has sometimes been described as new in different genera.

Parioglossus was defined by Regan (1912) on the basis of its separate pelvics, strongly compressed head and body, oblique, protractile mouth, small body scales, vertical gill openings and dorsal and anal fins consisting of one spine and 15–16 rays. Several genera that we regard here as junior synonyms of *Parioglossus* have been described. Smith (1931a) erected the genus *Herrea*, which was found to be preoccupied and was replaced first by *Herreolus* (Smith 1931b) and subsequently (see Smith, 1945) by *Herreichthys* (Koumans 1931). Herre (1939) described *Andameleotris*, as a subgenus of *Amblyeleotris* and incorrectly reported it as having one spine, three rays in the pelvic fin and six branchiostegals. *Andameleotris* was subsequently recognized as a genus with the description of *A. palustris* (Herre 1945a). In

recognizing *A. palustris* as the type of *Andameleotris*, it could be argued that Herre (1945a) effectively created a primary homonym of his earlier (1939) useage of the name *Andameleotris* with *Amblyeleotris raoi* as the type-species by monotypy. However, under strict interpretation of the International Code of Zoological Nomenclature Articles 43, 61, 67 and 68, the designation of *Andameleotris palustris* as the type-species is invalid, since it is clear that Herre (1945a) was elevating his previous subgenus to a genus. Both useages are listed in the generic synonymy for completeness.

With the exception of *P. nudus*, which differs from other species in lacking scales on the body and being found to depths of 37m, well beyond the known depth of the other species, the members of the group are very similar in meristics and morphology. Since some features, such as head pores, vary with size as well as geographically, the easiest way to distinguish a species is by coloration, which varies little within each species over its geographic range. Sexual dichromatism, however, is apparent in several of the species and is most pronounced in *P. marginalis*.

Miller (1971) described the osteology of *Parioglossus* and concluded the genus was gobiid rather than eleotrid in structure, with the separation of the pelvic disc having been derived secondarily from the typical fused fins of gobiids. However, no known relative possesses a pelvic disc and the separation of the pelvic fins may indicate the retention of a primitive condition. *Parioglossus* shares several specializations with *Ioglossus* Bean, *Ptereleotris* Gill, *Oxymetopon* Bleeker, and *Nemateleotris* Fowler (all of which have separate pelvic fins), including the development of a long, posterior pelvic process, an oblique and often almost vertical protrusible mouth, the absence of a separate articular process on the premaxilla, and usually a single pterygiophore (rather than two) preceding the first hemal spine. Hoese (in press) placed these genera in the subfamily Ptereleotrinae and provisionally placed the subfamily in the family Microdesmidae.

Ptereleotrine gobioid fishes are unusual and, possibly, unique among gobioid fishes, in having a highly protrusible mouth. Normally in gobioid fishes the rostral cartilage is oval, flattened anteriorly and ventrally, and tightly bound to the back side of the ascending processes of the premaxillae. The cartilage is also connected to the anterior end of the maxilla. In these fishes the jaws cannot be pulled far forward without tearing the connections. However, in *Ptereleotris* and *Parioglossus*, the rostral is flattened laterally and attached only to the upper tip of the ascending processes of the premaxillae as well as to the anterior ends of the maxillae. When the jaw is pulled forward the rostral rotates, with the dorsal end of the rostral remaining close to the ascending processes of the premaxillae and the ventral end between the upper ends of the maxillae, allowing the jaws to move forward. In *Nemateleotris* the rostral is tightly bound to the premaxillae and does not rotate, and the jaw is only slightly protrusible.

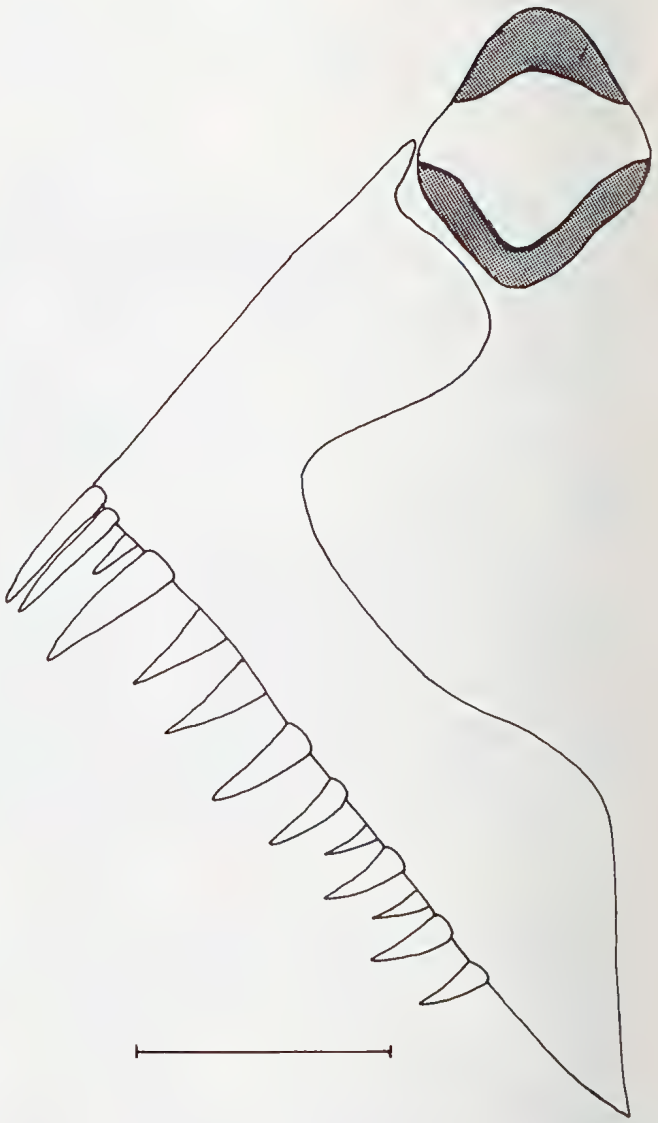

Fig. 1. Premaxilla and rostral bone of *Parioglossus formosus* (20 mm), with jaw partly protruded. Shaded area indicates cartilage on rostral. **Scale** = 0.5 mm.

Parioglossus is unusual in that seven of the 11 species for which the osteology was examined have some ossification of the rostral (Fig. 1). Of the few species of *Ptereleotris* and *Nemateleotris* examined none has an ossified rostral. Two of the seven species of *Parioglossus* with an ossified rostral were counter stained with alcian blue and found to have a broken median ring of cartilage around the bone. In other species the entire structure is composed only of cartilage.

Springer (1983) recorded an ossified rostral in *Xenisthmus*, *Tyson* and one species of *Kraemeria*, and partial ossification in one species of microdesmid. In *Tyson* and *Xenisthmus* the rostral is elongate and structurally unlike the rostral in ptereleotrines. In *Kraemeria* the rostral is oval, as is typical of most other gobioid fishes, but lies slightly behind the ascending processes of the premaxillae. Since *Nemateleotris*, which has a cartilagenous rostral, appears to be more primitive

among pterelectrines in having five pelvic rays, a less protrusible mouth and large ctenoid scales, it appears likely that the ossification of the rostral in *Parioglossus* has evolved independently.

Parioglossus is readily distinguishable from other pterelectrine gobioids by the following combination of characters: pelvics I,4; first dorsal pterygiophore formula (as defined by Birdsong, 1975) 3(22110); gill opening narrow to moderate, ending ventrally below the operculum; interorbital head pores paired laterally when present; second dorsal I,13–19. *Parioglossus* is most similar to *Pterelectris*, which differs in having a broader gill opening reaching ventrally to below the posterior preopercular margin, dorsal pterygiophore formula of 3(32010) and second dorsal I,24–39. *Ioglossus* agrees in all the features listed for *Pterelectris*, except that Atlantic species have two pterygiophores preceeding the first hemal arch. At present it is unclear whether *Ioglossus* warrants generic recognition.

Nemateleotris differs from other pterelectrine genera in having five pelvic segmented rays, and extensive development of ctenoid scales (presumably primitive features) and filamentous anterior dorsal spines. *Oxymetopon* differs from other genera in the subfamily in having a strongly compressed head and body, and a bony median crest behind and sometimes between the eyes. *Orthostomus* Kner is often placed close to *Oxymetopon*, but its status is uncertain. Of the genera in the subfamily only two have been reviewed recently, *Nemateleotris* by Randall and Allen (1973) and *Oxymetopon* by Klausewitz & Conde (1981).

Seven of the 14 species of *Parioglossus* have been described previously: *P. dotui*, *P. formosus*, *P. palustris*, *P. philippinus*, *P. rainfordi*, *P. raoi* and *P. taeniatus*. Six new species are described here: *P. aporos*, *P. lineatus*, *P. marginalis*, *P. nudus*, *P. triquetrus* and *P. verticalis*. One species will be described by Senou and Suzuki (in press): *P.* sp.

Methods

Measurements and counts follow those described by Hubbs and Lagler (1974) except as noted below. All lengths are in mm standard length and all measurements, including standard length, were taken with an ocular micrometer and are expressed as percent of standard length unless otherwise stated. Rays refer to segmented soft rays. Body depth was taken at the anal fin origin. Head pores include both circumorbital pores (above and behind eye) and preopercular pores, and the counts are from one side of the head (Fig. 2). Typical head papillae pattern is shown in Fig. 3. Gill-raker count refers to the outer face of the first gill arch upper + (angle + lower). Branchiostegals were counted from ventral to dorsal (i.e. branchiostegal 1 is the most ventral ray, branchiostegal 5 is the most dorsal). Longitudinal scale counts were taken from the upper posterior edge of the pectoral-fin base to the last scale on the caudal peduncle, excluding scales on the base of the caudal fin. The last dorsal and anal ray as counted is branched through the base. Vertebrae and procurrent caudal rays were counted for specimens of all species from radiographs. All colour descriptions refer to colour in alcohol unless noted otherwise. Comparison of characters (Table 3), morphometrics of the holotypes (Table 4), morphometrics of all material (Table 5), meristics of the dorsal fins and anal fin (Table 6), pectoral and caudal fins (Table 7), and procurrent caudal-fin rays (Table 8), longitudinal scale counts (Table 9) and total gill-raker counts (Table 10) are given for each species. The osteology of 11 species was examined from specimens cleared with trypsin and stained with alizarin. Specimens of 5 species (*Parioglossus dotui, P. formosus, P. marginalis, P. philippinus* and *P. raoi*) were counter stained with alcian blue.

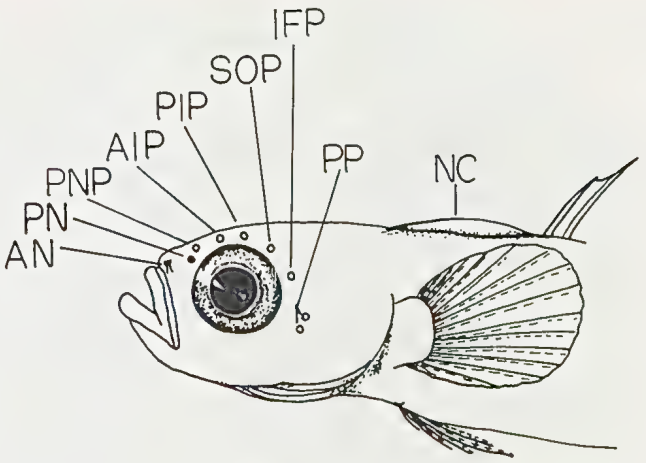

Fig. 2. Head pore terminology and nuchal crest of *Parioglossus*: anterior interorbital pore (**AIP**); anterior nostril (**AN**); infraorbital pore (**IFP**); nuchal crest (**NC**); posterior interorbital pore (**PIP**); posterior nostril (**PN**); posterior nasal pore (**PNP**); preopercular pore (**PP**); supraocular pore (**SOP**).

Material was examined from the following institutions: Australian Museum, Sydney (AMS); Academy of Natural Sciences, Philadelphia (ANSP); British Museum (Natural History), London (BMNH); Bishop Museum, Honolulu (BPBM); California Academy of Sciences, San Francisco (CAS); Stanford University (specimens now held in CAS) (CAS-SU); Kanudi Fisheries Research Station, Papua New Guinea (FO); Institute of Oceanic Research and Development, Tokai University, Japan (IORD); Laboratory of Ichthyology, The Crown Prince's Palace, Tokyo (LICPP); National Science Museum, Tokyo (NSMT); Northern Territory Museum, Darwin (NTM); Queensland Museum, Brisbane (QM); Rijksmuseum van Natuurlijke Historie, Leiden (RMNH); Royal Ontario Museum, Toronto (ROM); Subtropical Marine Laboratory, Irimote Marine Research Station, Tokai University, Japan (SMLVO); National Museum of Natural History, Washington, D.C. (USNM); Western Australian Museum, Perth (WAM); Instituut voor Taxonomische Zoölogie (Zoölogisch Museum), Amsterdam (ZMA).

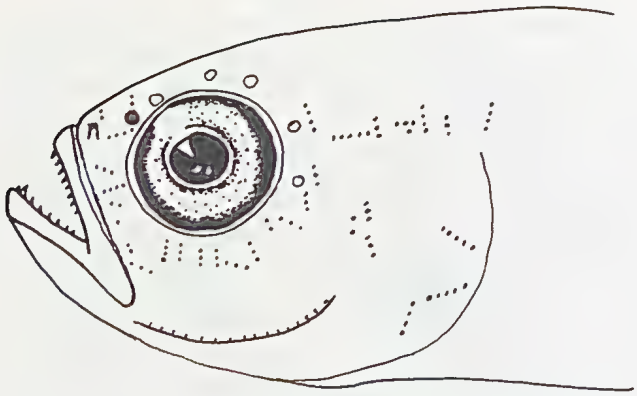

Fig. 3. Typical head papillae pattern of *Parioglossus* based on a composite.

The descriptions and key have been prepared largely from the larger and best specimens. In some cases characters change with size. For example, the head pores are incompletely developed in small specimens, generally below 15 mm. Similarly, the second dorsal and anal rays are often branched in large specimens of some species but largely unbranched or only with a narrow branch at the distil tip in small specimens. Colour can also change slightly with size, with the lateral stripe often most prominent in small specimens. Although the changes may be related to maturity, in many cases small females with eggs do not have fully developed characters. Other features were often difficult to determine from all specimens. For example, the presence or absence of scales on the belly, pectoral-fin base, predorsal and prepelvic areas often could not be determined without dehydrating or staining the specimens. The scales in this region are minute, deciduous, and often covered with mucous. Similarly the development of the nuchal crest was determined with considerable subjectivity, apparently varying to some degree with the state of preservation of the specimen. Little material was available from the Indian Ocean. The material that was available indicated that additional species, or geographical variants of the species recognized here, may exist in that region. Similarly material of some species from Japan was not available to us and information on these species was provided by H. Senou.

Parioglossus Regan

Parioglossus Regan, 1912: 302 (type-species, *P. taeniatus* Regan, by monotypy).

Herrea Smith, 1931a: 40 (type-species, *Herrea formosa* Smith, by monotypy), preoccupied by *Herrea* Whitley, 1930.

Herreolus Smith, 1931b: 190 (replacement for *Herrea* Smith).

Herreichthys Koumans, 1931: 163 (replacement for *Herrea* Smith).

Amblyeleotris (*Andameleotris*) Herre, 1939: 346 (type-species, *A. raoi* Herre, by monotypy).

Andameleotris Herre, 1945a: 2 (designated type-species, *A. palustris* Herre, by original designation, an invalid designation).

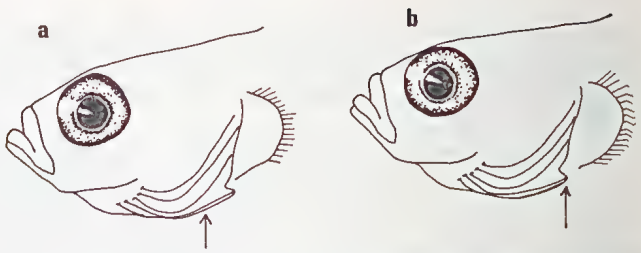

Fig. 4. Extent of gill openings in *Parioglossus*. Arrow indicates position of lower attachment of gill membrane to isthmus: a wide opening of *P. dotui* (a) and a narrow opening of *P. philippinus* (b).

Diagnosis. Head and body compressed; body elongate; ventral and dorsal profiles straight; cheek, preoperculum and operculum naked; body scaled or not, when scaled, scales cycloid, imbricate or nonimbricate in 61–109 vertical rows; mouth terminal, highly protractile, inclined at angle of 55–90° to longitudinal axis of body; maxilla reaching posteriorly to a point below anterior edge of eye; snout short, blunt, less than eye diameter; anterior nostril a shortened tube or a simple pore; posterior nostril a simple pore; no teeth on vomer, tongue or palatines; teeth conical; upper jaw with two rows of teeth anteriorly, outer row enlarged, widely spaced, 1–2 rows posteriorly; lower jaw uniserial posteriorly and 2–3 rows of closely spaced, enlarged teeth anteriorly, inner row with 1–3 notably enlarged teeth on either side of midline; tongue tip truncate to slightly round; circumorbital and preopercular pores present or absent; head papillae present, varying in number and size depending on species; median nuchal crest, formed by low fold of skin from first dorsal spine onto head, low to prominent; gill opening vertical, extending ventrally from point immediately above upper pectoral-fin base to point just below lower pectoral base to an eye diameter anterior to pectoral base, below operculum (Fig. 4); interorbital about ½ diameter of eye; total gill-rakers on first arch 12–20, compressed, elongate; all rakers ossified; rakers on second, third and fourth arches tuberculate with dorsal spiny projections; 2 dorsal fins, first dorsal fin V–VI, second dorsal fin I,13–19; anal fin I,13–19; pectoral fin 15–20; segmented caudal rays usually 9+8 (occasionally 8+7 or 9+7); branched caudal rays usually 7+6 or 6+5; pelvic fins separate I,4; vertebrae 10+16; branchiostegals 5.

Osteology. Lacrimal small poorly ossified; rostral, an ossified bone or cartilage not strongly bound to premaxilla and not broadly attached to the dorsoposterior margin of the ascending process of the premaxilla (Fig. 1); nasal bone poorly ossified; ascending and articular processes not individually distinguishable (Fig. 1) on each premaxilla; metapterygoid very slender and elongate, not reaching ventrally to quadrate; no mesopterygoid; preoperculum with prominent anterior process articulating with dorsal end of symplectic; posterior flange of hyomandibular sometimes with a short ventral process connected to dorsal margin of preoperculum; sphenotic small, with a prominent dorsal flange sometimes meeting supraoccipital but often with pterotic extending between

supraoccipital and sphenotic; frontal large forming dorsal and posterodorsal part of orbit; supraoccipital diamond-shaped with prominent median posterodorsal flange; posttemporal forked; cleithrum bifid dorsally; no dorsal postcleithrum; ventral postcleithrum present or absent; ventral intercleithral and pelvic intercleithral cartilage present (as defined by Springer, 1983); scapula cartilagenous; lateral flanges of pelvic bone longer than conical portion; posterior pelvic process extending well behind bases of pelvic rays; base of pelvic spine with dorsal and ventral processes; neural spines on vertebrae 1–21, and hemal spines on vertebrae 11–21 originating on anterior edge of centrum, on 22 on central surface, on 23–25 on posterior edge; parapophysis of precaudal vertebra 10 longest; precaudal vertebrae 1 and 2 with epipleural ribs only, vertebrae 3–10 with epipleural and pleural ribs; epipleural ribs sometimes present on caudal vertebrae 1–4; precaudal vertebrae 2–10 with dorsal prezygapophyses; all but last 3–4 caudal vertebrae with prezygaphophyses; dorsal postzygapophyses present or absent; 2 pterygiophores between neural spines 3 and 4, 2 between neural spines 4 and 5, 1 between neural spines 5 and 6, 1 between neural spines 6 and 7 [3(22110)]; 1 anal pterygiophore precedes first hemal arch; last dorsal and anal pterygiophore each support 2 rays; urostyle completely fused to upper hypural plate; lower hypural plate articulates anteriorly to urostyle; parhypural tapered with small dorsal and large ventral flange; hypural 5 with small dorsal and ventral flange; 7 segmented rays on upper plate, 6 on lower; 1 segmented ray on hypural 5, 1 on single epural, 1 on parhypural, 1 on last hemal spine.

Key to Species of *Parioglossus*

1. No head pores.....2
——Head pores present.....3

2. Branched caudal rays 6+5; body naked; anal I,16–17 (usually I,16)...Fiji, Solomon Islands, Papua New Guinea, Palau, Philippines.....*P. nudus* n. sp.

——Branched caudal rays 7+6; body scaled; anal I,13–14 (usually I,14)...Indonesia.....*P. aporos* n sp.

3. 13 vertical bars on side below second dorsal fin; scales imbricate; dark ring around anus of males...Caroline Islands.....*P. verticalis* n. sp.

——No vertical bars below second dorsal fin; scales imbricate or nonimbricate; dark ring around anus present or absent.....4

4. Distinct, dark lateral stripe present on body (Figs 7, 15).....5

——Lateral stripe absent or diffuse stripe present, but without distinct dorsal and ventral margins (Figs 5, 6).....9

5. Scales imbricate; posterior nasal pore usually absent.....6

——Scales nonimbricate; posterior nasal pore present.....8

6. Dorsal and anal fins usually I,15 (rarely I,16); posterior dorsal and anal rays branched.....7

——Dorsal and anal fins usually I,17–18 (rarely I,16); posterior dorsal and anal rays unbranched (preopercular pores present in specimens greater than 17 mm; large round spot at base of middle to ventral caudal rays; no black spot at base of dorsal spines 5 and 6)...Papua New Guinea, Irian Jaya, Japan. .....*P.* sp.

7. Dorsal edge of lateral stripe below midline of side of body; black spot at base of dorsal spines 5 and 6; circumorbital pores 2–4; preopercular pores present or absent...Fiji, Caroline Islands, Irian Jaya, Indonesia, Philippines, Japan, Andaman Islands.....*P. raoi* (Herre)

——Dorsal edge of lateral stripe along midline; no black spot at base of dorsal spines 5 and 6; circumorbital pores usually 4, rarely 5; preopercular pores present... Fiji, Vanuatu, Palau, Philippines, Aldabra.....*P. taeniatus* Regan

8. Dorsal stripe on caudal fin present, extending obliquely downward to tips of rays above middle of fin; no dark vertical bar at base of caudal fin;

preopercular pores present in specimens greater than 20 mm; dorsal and anal fins I,13–15, usually I, 14; pectoral fin 15–17; dorsal spines 3 and 4 longest in males; anterior nostril a short tube...Fiji, Vanuatu, Palau, Australia, Papua New Guinea, Indonesia, Philippines, Japan.....*P. formosus* (Smith)

——No dark stripe on caudal fin; dark vertical bar at base of caudal rays; preopercular pores absent; dorsal and anal fin I, 15–16; pectoral fin 18–20; dorsal spines 4 and 5 longest in males; anterior nostril a simple pore...Palau, Solomon Islands.....*P. lineatus* n. sp.

9. Branched caudal rays usually 6+5, rarely 6+6; posterior dorsal and anal rays usually unbranched, occasionally branched but rarely are all rays branched; gill opening narrow, ending ventrally just below lower pectoral base (Fig. 4b)...Australia, New Britain, Philippines, Gulf of Thailand, India, Madagascar.....*P. philippinus* (Herre)

——Branched caudal rays 7+6, rarely 6+6; posterior dorsal and anal rays branched or unbranched; gill opening ending ventrally from below pectoral base to below middle of operculum.....10

10. Large, round spot on base of ventral caudal rays (usually rays 9–15); posterior dorsal and anal rays unbranched; preopercular pores present in specimens greater than 20 mm...Australia, Papua New Guinea, Borneo, Philippines, Japan.....*P. palustris* (Herre)

——No large round spot confined to base of ventral caudal rays (if spot present, extending above midline); posterior dorsal and anal rays branched in specimens greater than 22 mm; preopercular pores present or absent.....11

11. Gill opening narrow, lower attachment of branchiostegal membrane just below pectoral base (Fig. 4b); preopercular pores present (sometime absent in specimens less than 19 mm); mouth angle 85–90° to longitudinal axis of body; (anterior nostril a simple pore; males with a vertical bar at base of caudal rays, ventral portion of bar extending posteriorly towards tips; females with a round spot on rays 4–12)...Australia, Papua New Guinea, Irian Jaya, Caroline Islands, Palau, Indonesia, Philippines, Japan. .....*P. rainfordi* McCulloch

——Gill opening wide, lower attachment of branchiostegal membrane below middle of operculum (Fig. 4a); preopercular pores absent; mouth angle of 60–75° to longitudinal axis of body.....12

12. Anterior nostril a simple pore; females with pale anus; caudal fin with a triangular to rectangular spot on base of caudal rays, often with 1–2 smaller spots on caudal peduncle anterior to caudal fin spot; caudal fin truncate, males larger than 20 mm with rays 13–14 elongate...Fiji. .....*P. triquetrus* n. sp.

——Anterior nostril a short tube; females with black ring around anus; caudal fin with a stripe, round to elongate spot or several vertical bars; caudal fin truncate to emarginate, males larger than 20 mm without rays 13–14 elongate or, if rays elongate, some dorsal caudal rays elongate as well.....13

13. Dark stripe posterior to eye; no dorsal spines elongate in males; males and females with distinct round to horizontally elongate spot on middle caudal rays, sometimes extending to tips of middle caudal rays; second dorsal and anal fins usually I,16-17; nuchal crest low in both sexes... Japan. .....*P. dotui* Tomiyama

——No dark stripe posterior to eye; dorsal spine 5 elongate in males; males and females without distinct round to horizontally elongate spot on middle caudal rays, males with stripe on middle rays of caudal fin extending to tips of rays, females with 3–4 vertical bars on middle rays; second dorsal and anal fins usually I,17–18; nuchal crest prominent in both sexes... New South Wales, Australia.....*P. marginalis* n. sp.

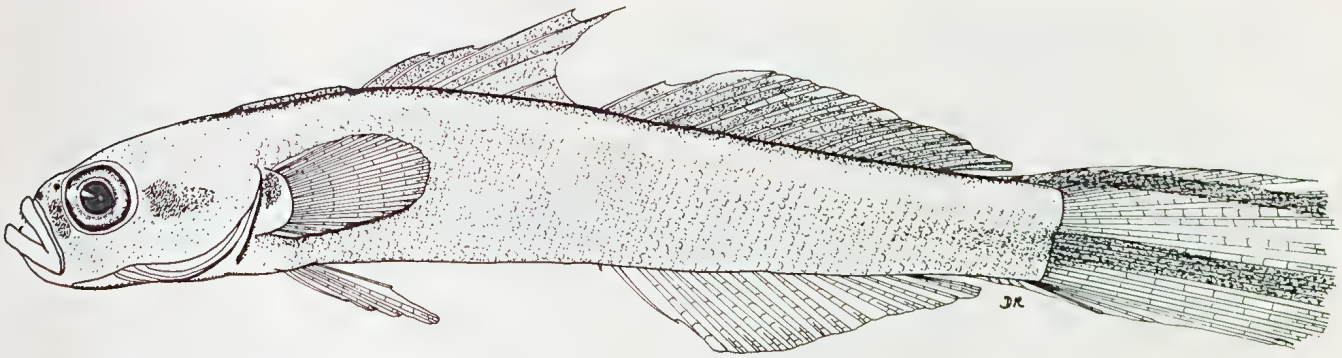

Fig. 5. *Parioglossus aporos*, holotype, male 24.2 mm, Indonesia, USNM 257045 (body slightly arched, caudal fin damaged).

Parioglossus aporos n. sp.
Figs 5, 19, 33

Type material. HOLOTYPE: USNM 257045, Tandjung Paprekama, Teluk Buton, Indonesia, 5°24'30''S, 122°37'28''E, 1–8 m depth, 25 March 1974, collected by V. G. Springer and M. F. Gomon, male, 24.2mm. PARATYPES: AMS I.24319-001, type locality, 3(14–22 mm), cleared and stained, 1(21 mm); USNM 260326, type locality, 13(10–22 mm), cleared and stained, 1(22 mm).

Diagnosis. Dorsal fins VI + I, 13–15 (usually I, 14); anal fin I, 13–14; pectoral fin 15–16 (usually 15); branched caudal rays 7+6; longitudinal scale count 63–75, scales nonimbricate; gill opening moderate, extending ventrally to just below lower margin of pectoral base and behind middle of operculum; gill rakers 2+10–13; no head pores; nuchal crest a low fold in both sexes, extending forward to above middle of operculum; dorsal spines 3–5 elongate in males over 21 mm, none elongate in females; second dorsal and anal rays branched in two specimens (22–24mm), unbranched in specimens 13–21 mm, except rays 2 to 4 or 5, sometimes branched; caudal fin truncate to slightly emarginate in females, males with dorsal and ventral lobes elongate; blackish lateral stripe absent or diffuse anteriorly; black stripe ventral to midline present from above anal fin extending to caudal fin at base of caudal rays 9–15 and to tip of rays 10–11.

Description. Rostral bone present; ventral postcleithrum present. Scales present from opercular margin to end of caudal peduncle, absent from dorsolateral surface of body, midline of belly, prepelvic area and pectoral-fin base. Mouth inclined at angle of 60–70° to longitudinal axis of body; anterior nostril a simple pore. Males with dorsal spines 1–4 increasing progressively in length, spine 4 longer than spine 5, 5 longer than 6; dorsal spines 3–5 elongate in males over 21 mm, spine 4 reaching to beyond second dorsal origin; no spines elongate in females, spines 2–5 about equal in length, longer than spines 1 and 6; anterior dorsal and anal rays 2–4 longest in males, posterior rays decreasing slightly in length to last ray, which is longer than penultimate ray; anterior dorsal and anal rays 3 – 5 longest in females, rays decreasing in length posteriorly; last rays not reaching beyond caudal peduncle in either sex; pectoral fins oblong, less than head length; only innermost pelvic ray unbranched, others branched, pelvic ray 3 longest.

Colour in alcohol. Body brown, head dusky; dark stripe on dorsal midline from nuchal crest extending to caudal fin, diagonally across caudal rays 1–6; dusky to dark patch behind eye, on operculum and upper edge of pectoral fin; first dorsal dark, second dorsal dark with white edge; other fins pale.

Distribution. Coastal waters of Indonesia.

Comments. This species is similar in fin-ray counts and caudal-fin coloration to *P. formosus*; however, the lack of any head pores in *P. aporos* easily distinguishes the larger specimens of this species. Specimens of *P. formosus* and *P. raoi* smaller than 15 mm may lack head pores so colour pattern differences are then the best way for separating *P. aporos* from those species. *Parioglossus formosus* has a distinct lateral stripe and *P. raoi* has no middorsal stripe (except in specimens from Japan). Specimens of *P. raoi* from Japan also sometimes lack head pores but differ from *P. aporos* in having a tubular anterior nostril and a black spot near the end of the first dorsal fin. Smaller specimens of *P. raoi* have an enlarged caudal-fin spot that extends dorsal to the midline. *Parioglossus aporos* also tends to have lower pectoral-fin ray counts (mode of 15 in *P. aporos*, 16–17 in *P. formosus*, 16 in *P. raoi*). *Parioglossus aporos* is known only from a single collection.

Etymology. From the Greek, *a* = without and *poros* = pores, named for the lack of head pores.

Parioglossus dotui Tomiyama
Figs 6, 20, 34

Parioglossus taeniatus.— Dôtu, 1956: 489, 3 text figs (Kyushu and Shikoku, Japan).

Parioglossus dotui Tomiyama, 1958: 1179, pl. 230, fig. 582 (Mogi, Nagasaki Prefecture, Japan).— Tomiyama, 1959: 103 fig. 4 (Chiba Prefecture, Japan); Hayashi, Suzuki, Ito, and Senou, 1981: 14, pl. 11, fig. 147 (Urauchigawa River, Japan).

Material examined. AMS I.23491-001, Hirakubo River, Ishigakijima, Okinawa Prefecture, Japan, 2(15–18 mm); AMS I.23698-001, mouth of Shimonokae River, Koochi Prefecture, Japan, 60(20–25 mm), cleared and stained, 5(20–24 mm); IORD 77-497-501, Udara River, Amitori Bay, Iriomotejima,

Okinawa Prefecture, Japan, 5(20–22 mm); LICPP 1951019, Mogi, Nagasaki Prefecture, Japan, 2(30–31 mm); LICPP 1981063, Ayanda River, Iriomotejima, Okinawa Prefecture, Japan, 3(12–18 mm); NSMT-P6037-6043, Mizusaki, Asaji Bay, Tsushima Island, Nagasaki Prefecture, Japan, 7(25–29 mm); SMLVO 77-221-225, Udara River, Amitori Bay, Iriomotejima, Okinawa Prefecture, Japan, 4(18–25 mm).

Diagnosis. Dorsal fins VI + I, 16–17; anal fin I, 16–18; pectoral fin 17–20; branched caudal rays usually 7 + 6, occasionally 6 + 6; longitudinal scale count 74–88, scales nonimbricate; gill opening moderate, extending ventrally to below middle of operculum; gill rakers 3–4 + 13–15; 5 head pores above and behind eye, no preopercular pores; nuchal crest a low fold in both sexes, extending forward to above middle of operculum; no dorsal spines elongate in either sex; dorsal and anal rays, excluding first ray of each fin, branched in specimens larger than 22mm; caudal fin truncate to emarginate; females with prominent black ring around anus; males with narrow dark ring around anus; prominent dark stripe present from posterior margin of eye to upper pectoral-fin base and from caudal peduncle to tips of rays 9–10; faint stripe on side of body ventral to midside.

Description. Rostral cartilage not replaced by bone; ventral postcleithrum absent. Anterior extent of predorsal scales from above middle of operculum in a straight line to just below dorsal spine 2; scales on body extending posteriorly onto caudal-fin base, not present immediately below dorsal fins; belly and pectoral-fin base scaled, prepelvic naked or with few scales. Mouth inclined at angle of 60–70° to longitudinal axis of body; anterior nasal tube short; head pores 5: posterior nasal pore, anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore. Membrane from dorsal spine 6 to second dorsal fin low in both sexes; dorsal spines increasing in length to spine 5 which is longer than spine 6; second dorsal and anal rays 3 and 4 longest, posterior rays decreasing in length gradually; last ray not reaching beyond caudal peduncle; pectoral fins oblong, length of fins less than head length; inner pelvic ray unbranched, others branched, pelvic ray 3 longest, but not elongate.

Colour in alcohol. Body yellowish; head dusky; dusky to dark stripe across snout, posterior to eye, over upper edge of operculum and pectoral-fin base, continuing across body ventral to midside (usually faded) to caudal peduncle (usually dark), onto caudal fin at bases of rays 8–12 to tips of rays 9–10; dusky to black stripe on dorsal midline from head to posterior caudal peduncle; dorsal fins dusky; outer half of anal fin dark (often faded) in males; other fins pale. Tomiyama (1958) noted that in life this fish has a silvery operculum and a pale green body with a dark stripe along the side.

Distribution. Estuarine to marine in bays and coastal waters of Japan.

Comments. *Parioglossus dotui* has been confused with *P. philippinus* by Miller (1971) and *P. taeniatus* by Dôtu (1956) due to a similarity in body coloration. The black anus in females of *P. dotui* is a distinguishing characteristic. The only other species with a black anus in females is *P. marginalis* which can be separated on the basis of fin ray counts and body coloration. Because both *P. philippinus* and *P. dotui* may have 6+6 branched caudal rays and *P. dotui* smaller than 22 mm have unbranched posterior dorsal and anal rays, problems may arise in separating these species, especially when body colour has faded. *Parioglossus philippinus* has a narrower gill opening extending ventrally to just below the pectoral base, a ventral postcleithrum (versus absent), average higher dorsal-fin ray counts (usually I, 17–18 versus usually I, 16–17), lower longitudinal scale counts (usually 61–72 versus 74–88), higher procurrent caudal-ray counts, usually unbranched posterior dorsal and anal rays, less extensive development of anterior scales, a naked pectoral-fin base, longer pelvic fins in males and a more elongated fifth dorsal spine in males. *Parioglossus taeniatus* and *P. formosus* can be distinguished from *P. dotui* by fin-ray counts, differences in male dorsal-spine lengths, and the absence of preopercular pores in *P. dotui*. Miller (1971) identified specimens from Ratnagiri, India as *P. dotui* on the basis of dorsal and anal fin counts and longitudinal scales; however, upon examining these specimens, the characteristics are those of *P. philippinus* rather than *P. dotui*. The possibility exists that *P. dotui* and *P. philippinus* merely represent different populations of the same species. *Parioglossus dotui* is restricted to Japan, occurring as far south as the southern Ryukyu Islands, and *P. philippinus* is known from the Indian Ocean and western Pacific. However, since the two species are apparently sympatric in Japan (Senou, personal communication), and the morphological differences appear to be consistent, the two species are regarded here as distinct. Specimens of

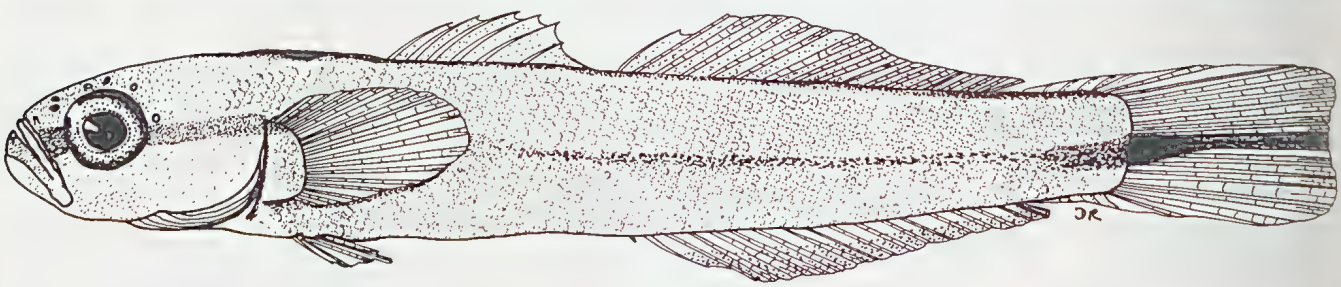

Fig. 6. *Parioglossus dotui*, male, 20 mm, AMS I.23698-001, Japan.

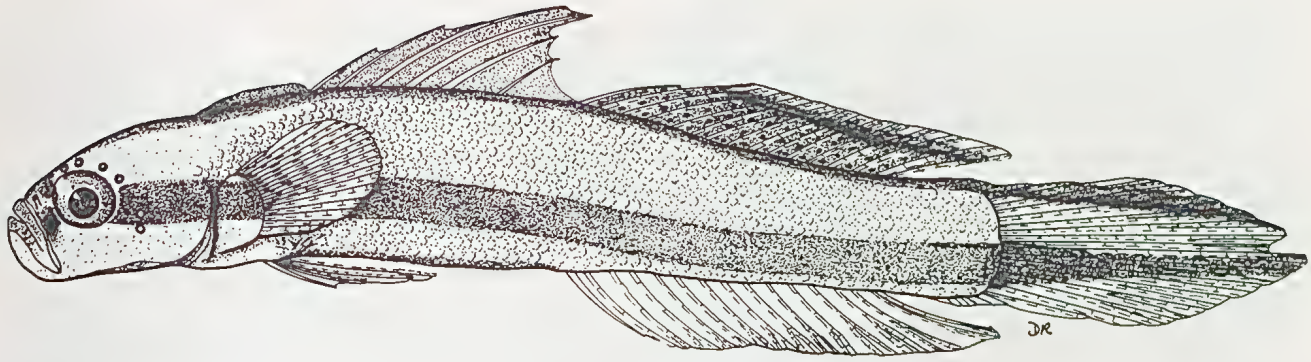

Fig. 7. *Parioglossus formosus*, male, 35 mm, CAS 36932, Gulf of Thailand (body arched).

P. dotui also resemble those of *P. verticalis* in meristic counts and width of the gill opening, but body coloration differs considerably.

Dôtu (1956) noted that this species (identified as *P. taeniatus*) lives a gregarious and semi-pelagic life feeding on planktonic copepods. The spawning season extends from July to September in the Amakusa Islands, Kyushu, Japan.

Parioglossus formosus (Smith)

Figs 1, 7, 21, 35

Herrea formosa Smith, 1931a: 40 (Koh Chula, Chantabun River, Gulf of Siam, Siam).

Herreolus formosus.— Smith, 1931b: 190 (replacement for *Herrea*); Herre, 1940: 364, pl. 6 (in part, Dumaguete, Philippines).

Herreichthys formosus.— Koumans, 1931: 163 (replacement for *Herrea*).

Ptereleotris taeniata taeniata.— Abe, 1939: 569 (Iwayama Bay, Palau Islands).

Parioglossus taeniatus.— Tomiyama, 1958: 1187, pl. 231, fig. 584 (Iwayama Bay, Palau Islands); Tomiyama, 1959: 103, fig. 3 (Iwayama Bay, Palau Islands); Hayashi and Itoh, 1978: 31, pl. 4, fig. 84 (Iriomotejima, Sumiyoshi, Japan).

Type material. NEOTYPE: USNM 119611, Koh Samet, Thailand, male, 23.5 mm.

Additional material. AMS IA.769, Vanuatu, 8(22–24 mm), cleared and stained, 3(24–30 mm); AMS IB.2958, Heron Island, Queensland, 1(20 mm); AMS I.19180-012, Fiji, 2(22–24 mm); AMS I.20392-001, Lizard Island, Queensland, 6(9–21 mm); AMS I.20785-008, Hartleys Creek, Queensland, 1(11 mm); AMS I.22138-001, Pandora Reef, Queensland, 4(12–26 mm); AMS I.23499-002, Ishigakijima, Japan, 16(16–24 mm); BPBM 9237, Palau Islands, 3(26–29 mm); CAS 27451, Goh Samet Island, Gulf of Thailand, 2(20–22 mm); CAS 29090, Ciagba Bay, Negros Island, Philippines, 1(18 mm); CAS 36927, Iwayama Bay, Palau Islands, 7(17–26 mm); CAS 36931, Goh Sak Island, Gulf of Thailand, 1(22 mm); CAS 36932, Hinson Chalam, Gulf of Thailand, 56(7–35 mm); CAS-SU 33116, Dumaguete, Philippines, 7(12–14 mm); LICPP 1980034, Arakawa, Ishigakijima, Japan, 5(20–24 mm); USNM 245268, Ravad Island, Papua New Guinea, 8(15–25 mm); USNM 257047, Palau Islands, 1(10 mm); USNM 257052, Philippines, 5(9–18 mm); USNM 260325, Buton Island, Indonesia, 2(10–20 mm); WAM P.24077, Kendrew Island, Western Australia, 1(16 mm).

Diagnosis. Dorsal fins V–VI + I, 13–15 (usually VI + I, 14); anal fin I, 13–15 (usually I, 14); pectoral fin 15–17 (usually 16–17); branched caudal rays 7+6; longitudinal scale count 66–78, scales nonimbricate; gill opening narrow, extending ventrally to just below lower margin of pectoral base and below rear quarter of operculum; gill rakers 3–4 + 12–14; 5 head pores around top and rear margins of each eye and 2 preopercular pores; nuchal crest a prominent fold in males, a low fold in females, extending forward to above middle to front of operculum; dorsal spines 3 and 4 elongate in males, none elongate in females; second dorsal and anal rays branched, except for first ray of each fin often unbranched; caudal fin truncate to slightly emarginate in females; caudal fin of males with upper and lower lobes elongate, lower lobe longer than upper in large males; wide, dark, lateral stripe extending across body (ventral to midside) to tip of caudal fin; second dark stripe along dorsal midline.

Description. Rostral bone present; ventral postcleithrum present. Anterior extent of predorsal scales from just anterior to posterior opercular margin, extending dorsally and posteriorly in a line with first dorsal spine to just below first dorsal fin; scales on body extending posteriorly to end of caudal peduncle; scales absent from area immediately below dorsal fin, pectoral-fin base, prepelvic area and midline of belly. Mouth at angle of 55–60° to longitudinal axis of body; anterior nostril a short tube; head pores: posterior nasal pore, anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore, 2 preopercular pores (not always present in specimens less than 20 mm). Membrane from dorsal spine 6 not attached to base of spine of second dorsal fin in females, attached in males. Males over 20 mm with spines 1–3 increasing in length, spines 3 and 4 elongate, reaching to or beyond origin of second dorsal fin, spine 5 shorter than spine 4, longer than spine 6, spine 6 reaching to second dorsal origin; females with spines 1–3 increasing in length, spines 3 and 4 about equal, spine 5 shorter than spine 4, longer than spine 6; no spines prolonged, none reaching to second dorsal origin; all second dorsal and anal rays of males approximately equal in length, last rays reaching to beyond caudal fin base; second dorsal and anal segmented rays 3 and 4 longest in

females, decreasing in length posteriorly; pectoral fin oblong, length less than head length; innermost pelvic ray only unbranched, others branched; pelvic rays 3 and/or 4 elongate in males, not reaching to anus; pelvic rays 3 and 4 not prolonged in females; caudal fin with rays 8–9 slightly shorter than rays 7 or 10; caudal fin of males with rays 6–7 and 10–11 elongate, rays 10–11 longer than 6–7.

Colour of fresh material. Body brown, belly white; dark stripe extending from behind eye onto pectoral-fin base and continuing behind pectoral fin to tip of caudal-fin rays on dorsal half of lower lobe; ventral half of lower lobe clear; dark stripe extending from nuchal crest along dorsal midline to tip of caudal-fin rays of dorsal lobe; dorsal margin of caudal fin and membrane between dorsal and ventral stripes clear; bluish green spot below eye; blue spot on base of middle caudal rays; dorsal fins dark, other fins pale.

Colour in alcohol. Dark stripe (width over anal fin greater than half diameter of eye and much greater than width of light area above anal fin) from lower jaw, across snout, continuing posterior to eye and extending over upper half of pectoral-fin base, along side of body (ventral to midline) to caudal fin on rays 9–16 at base and rays 10–11 at tip; narrower stripe along dorsal midline from tip of snout to caudal-fin base and extending obliquely to tip of caudal rays 5–7; narrow dark stripe on ventral midline of belly from behind pelvic-fin base to anus, often continuing along body just above base of anal fin; first dorsal fin dark; second dorsal fin dark with light edge; membrane of second dorsal fin sometimes with spots forming 4–5 transverse rows; pelvic, pectoral, anal, and dorsal and ventral edges of caudal fin, and portion between stripes on caudal fin, pale.

Distribution. Widespread from the Gulf of Thailand to Fiji, and Japan to Australia; found in shallow water of mangroves or coastal reefs, often in schools.

Comments. *Parioglossus formosus* is often collected with *P. raoi* and *P. taeniatus* and closely resembles these two in coloration. *Parioglossus formosus* generally has fewer dorsal- and anal-fin rays (I, 15 usually in *P. raoi* and *P. taeniatus*) and has 5 circumorbital pores whereas *P. taeniatus* usually has 4 and *P. raoi* usually has 2 – 3. In smaller specimens, where head pores are not fully developed, fin ray counts and differences in coloration will help to separate these species. *Parioglossus formosus* has a wider lateral stripe and distinct mid-dorsal stripe, which is absent in both *P. taeniatus* and *P. raoi*, with the exception of Japanese specimens of *P. raoi*. *Parioglossus formosus* is similar to *P. aporos* in fin-ray counts but *P. aporos* can be distinguished by the lack of head pores and the narrower lateral stripe prominent only from above the anal fin onto the caudal peduncle.

Smith (1945) noted that the original type material was lost and designated a neotype.

Parioglossus lineatus n. sp.

Figs 8, 22, 36

Type material. HOLOTYPE: CAS 36928, mangrove zone, Babelthuap Island, Arakitaoch Stream, Palau Islands, 7°23′24″N, 134°31′07″E, 30 October 1956, collected by Sumang, Marbou, and Fehlmann, male, 33.4 mm. PARATYPES: CAS 52779, cleared and stained, type locality, 1(31 mm); CAS 53330, type locality, 2(24.7–25.1 mm); AMS I.24320, 1(25 mm), and USNM 257043, 1(25 mm), possibly Guadalcanal Island, Solomon Islands, data uncertain.

Diagnosis. Dorsal fins VI + I, 15–16; anal fin I, 15–16; pectoral fin 18–20; branched caudal rays 7+6; longitudinal scale count 75–83 scales nonimbricate; gill opening narrow, ending ventrally just below lower pectoral-fin base and below rear quarter of operculum; gill rakers 3–4+15–16; 5 circumorbital pores around dorsal and posterior margins of each eye, no preopercular pores; nuchal crest a prominent fold in males, a low fold in females, extending forward to above middle of operculum; dorsal spines 4 and 5 elongate to filamentous in both sexes; second dorsal and anal fin rays branched, except first segmented ray of each fin often unbranched; caudal fin truncate in females, truncate to emarginate in males, lobes equal; dark lateral stripe present, dorsal edge of band along midside; vertical dark bar on base of caudal fin; dark stripe on dorsal midline.

Description. Rostral cartilage not replaced by bone; ventral postcleithrum absent. Anterior extent of predorsal scales from over posterior preopercular margin extending dorsally and posteriorly in line to below dorsal spine 1; scales on body extending posteriorly onto base of caudal fin; no scales immediately below first dorsal fin; belly and prepelvic area scaled; pectoral-fin base naked or with few scattered scales. Mouth inclined at angle of 65–75° to longitudinal axis of body; anterior nostril a simple pore; head pores: posterior nasal pore, anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore. Males (25–33 mm) with dorsal spines 4 and 5 longest, spines 4–6 extending to or beyond origin of second dorsal fin; females (25 mm) with dorsal spines 4 and 5 elongate, spine 5 reaching to about origin of second dorsal fin; dorsal and anal rays approximately equal length in males, except last ray of each fin which is slightly elongate, usually reaching to end of caudal peduncle; dorsal and anal ray 3 longest in females, rays decreasing in length posteriorly; pectoral-fin margin round, fin less than head length; innermost ray of pelvics unbranched and elongate in both sexes, not reaching to anus, other rays branched.

Colour in alcohol. Body yellow; brown lateral stripe (width above anal fin about equal to diameter of pupil) extending from behind eye, across upper operculum and pectoral-fin base, along trunk and tail with dorsal edge of stripe along midside and terminating at end of caudal peduncle (sometimes fading slightly before end of peduncle); brown vertical bar on bases of caudal rays

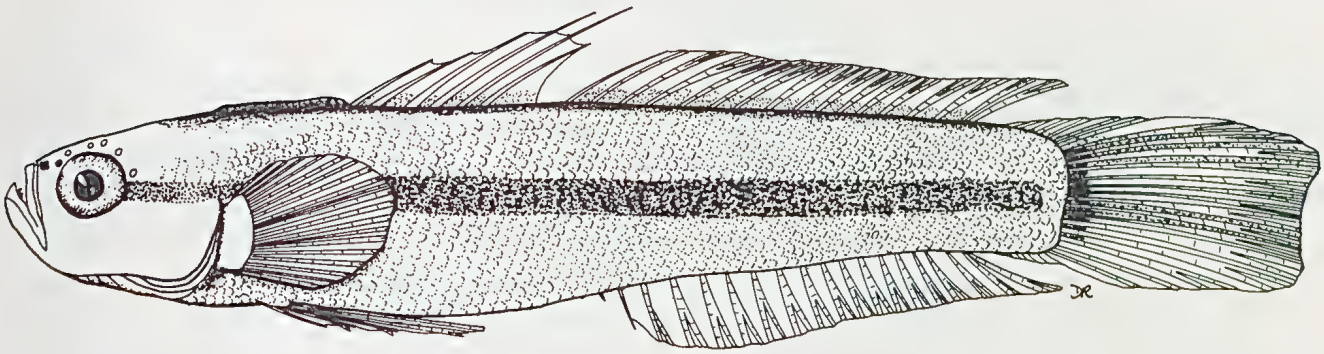

Fig. 8. *Parioglossus lineatus*, holotype, male, 33.4 mm, CAS 36928, Palau Islands.

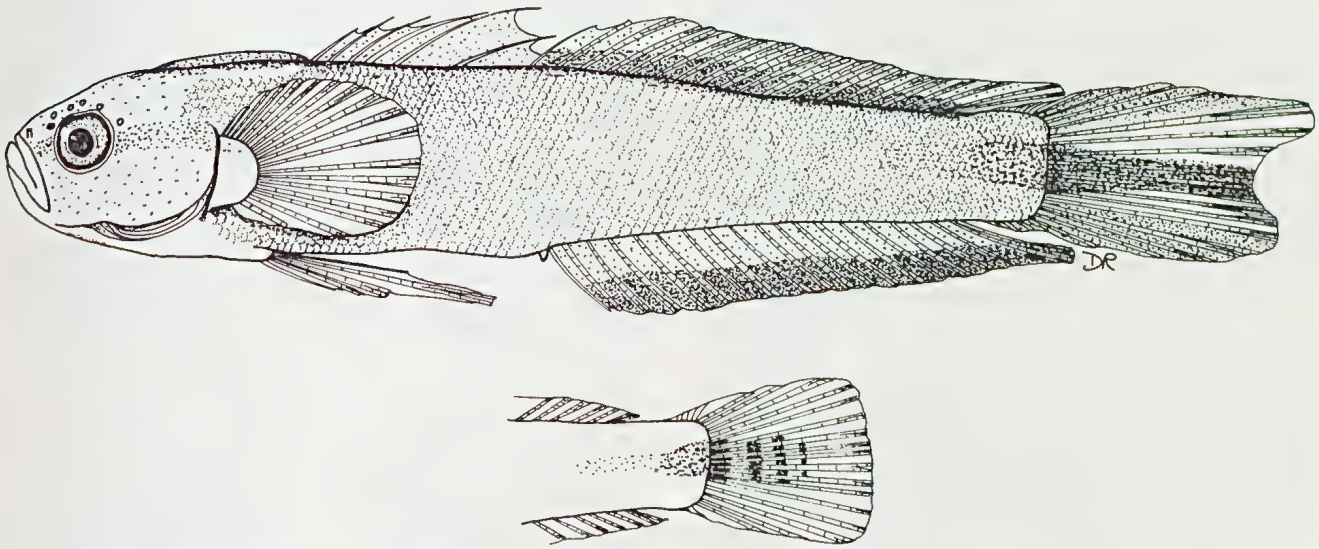

Fig. 9. *Parioglossus marginalis*, holotype, male, 35.5 mm, AMS I. 17459-007, and caudal pigment of female.

4–14; brown stripe on dorsal midline from beginning of nuchal crest to caudal fin extending onto caudal-fin rays 1–5; fins pale.

Distribution. Found in mangrove zones of the Palau Islands and possibly the Solomon Islands.

Comments. The prominent dorsal and lateral stripes and caudal bar and the high pectoral-fin ray and gill-raker counts distinguish this species from all others. The absence of preopercular pores and the elongate dorsal spines in both males and females will separate *P. lineatus* from *P. rainfordi* (males of which have a bar on the base of the caudal fin).

Etymology. From the Latin, *lineatus* = line, named for the two distinctive stripes and vertical band found on the body.

Parioglossus marginalis n.sp.

Figs 9, 23, 34

Type material. HOLOTYPE: AMS I.17459-007, Audley National Park, Port Hacking, New South Wales, 34°4'S, 151°5'E, 5 January 1974, collected by R. Kuiter, male, 35.5 mm. PARATYPES: AMS I.17443-001, Sydney Harbour, New South Wales, 33°51'S, 151°16'E, collected by R. Kuiter, 2(35–40 mm); AMS I.17459-004 type locality, 3(37 – 39 mm); AMS I.18241-013, Oakes Bay, Port Hacking, New South Wales, 34°04'S, 151°08'E, 0–6m, 14 November 1974, collected by D. Hoese and party, 48(21–38 mm), cleared and stained, 4(28–33 mm); AMS I.23876-001, no data, 1(37 mm); the following have the same data as AMS I.18241-013: BMNH 1983.7.25: 1–3, 3(28–33 mm); BPBM 29185, 4(29 – 34 mm); CAS 52780, 4(29–35 mm); QM I.20295 3(29 – 32 mm); USNM 260323, 4(30–34 mm); WAM P.28011-001, 3(32–33 mm).

Additional material. AMS IB.12 Port Hacking, New South Wales, 1(20 mm), in poor condition.

Diagnosis. Dorsal fins VI (rarely V) + I, 16–18 (usually I, 17–18); anal fin I, 17–18; pectoral fin 17–19 (usually 18–19); branched caudal rays 7 + 6; longitudinal scale count 90–105, scales imbricate on body, occasionally nonimbricate on caudal peduncle; gill opening moderate, extending forward to below and just behind middle of operculum; gill rakers 3–4 + 14–15; 5 circumorbital pores along dorsal and rear margins of each eye, no preopercular pores; nuchal crest a prominent fold in both sexes reaching forward to above middle of operculum, or to above posterior preopercular

margin in large specimens; dorsal spine 5 elongate in males; no spines elongate in females; posterior segmented dorsal- and anal-fin rays branched; caudal fin truncate to slightly emarginate in females, emarginate in males; rim around anus of females black; rim around anus of males pale; dark stripe from caudal peduncle to tip of middle caudal rays in males, females with 3–4 vertical bars on caudal fin.

Description. Rostral cartilage not replaced by bone; ventral postcleithrum absent. Anterior extent of predorsal scales from above middle of operculum extending dorsally to near nuchal crest (but excluding midline) and posteriorly to first dorsal spine; scales on body extending posteriorly onto base of caudal fin; no scales immediately below dorsal fins; top of caudal peduncle scaled; midline of belly, prepelvic area and pectoral-fin base naked. Mouth inclined at angle of 60–70° to longitudinal axis of body; anterior nostril a short tube; head pores: posterior nasal pore, anterior interorbital pore, posterior interorbital pore; supraocular pore; infraorbital pore. Membrane from sixth dorsal spine attached by membrane to spine of second dorsal fin above base; first dorsal fin low, spines increasing in height to spine 5, spine 6 shorter than 5; spine 5 elongate in males, reaching to first or second ray when depressed, not reaching to origin of second dorsal in females; females with dorsal and anal ray 3 longest, posterior rays decreasing in length; males with dorsal and anal rays approximately equal in length, except last ray which is slightly elongate, reaching beyond end of caudal peduncle; pectoral-fin margin round, fins slightly shorter than head length; only innermost pelvic ray unbranched, others branched; pelvic ray 3 elongate in males, not reaching to anus, slightly elongate in females; caudal fin of males with lower lobe equal to upper (in 6 out of 11 specimens) longer than upper (in 3 specimens), or shorter than upper (in 2 specimens).

Colour of live and fresh material. Body brownish dorsally with purple stripe above black mid-lateral stripe; belly white; cheek, operculum and pectoral-fin base with greenish-blue patches; males with margin of second dorsal fin and upper and lower lobes of caudal fin purple, outer half of anal fin black, and mid-lateral stripe extends to tips of middle caudal rays; females with dorsal and anal fins pale, dorsal half of caudal fin dusky, and 3–4 solid to broken black vertical bands along middle caudal rays.

Colour in alcohol. Body yellowish to brown; a diffuse, greyish stripe from snout to eye and from posterior margin of eye along upper preoperculum and operculum, fading on trunk (sometimes discernible) and appearing again on caudal peduncle; stripe extends onto base of caudal rays 6–12 and to tips of rays 8 – 10 or 11 in males; in females stripe extends to base of caudal rays 6–12 breaking into about 3 vertical bars on rays 8–11; males with dark stripe on dorsal and ventral caudal rays, and clear area between these and midcaudal stripe; dorsal midline with diffuse, greyish stripe; first dorsal dusky; males with basal half of second dorsal fin dark; males with outer half of anal fin membrane dusky to black; second dorsal and anal fins of females pale to dusky; pectoral and pelvic fins pale.

Distribution. Associated with sand and rocky substrates in shallow water of estuarine and coastal marine habitats; found in Port Hacking and Sydney Harbour, Sydney, New South Wales, Australia; seen in Wagonga estuary, southern New South Wales.

Comments. This is one of the two warm-temperate species of *Parioglossus*. It is a large species, reaching a length of 39mm, and exhibits a high degree of sexual dimorphism. In body coloration, males of *P. marginalis* are somewhat similar to *P. philippinus* and *P. dotui* whereas the females differ in coloration from these two species as well as from the males of *P. marginalis*. However, *Parioglossus philippinus* usually has 6+5 branched caudal rays and a lower longitudinal scale count, and has a ventral postcleithrum, and *P. dotui* has a lower average fin-ray count (I, 16–17 for both dorsal and anal fins) and a lower longitudinal scale count.

Etymology. From the Latin, *marginalis* = border, edge, named for the dark margins of the dorsal and ventral caudal lobes and margin of anal fin in males, and dark margin around the anus of the females.

Parioglossus nudus n. sp.

Figs 10, 24, 33

Type material. HOLOTYPE: CAS 36930, about 125 m northeast of southwest arm of Auluptagel Island, along reef which runs northeast to larger island in Risong Bay, Palau Islands, 7°17'59"N, 134°28'48"E, collected by H. DeWitt, Sumang, Sengich, and Exley, 29 November 1957, female, 19 mm. PARATYPES: AMS 1.24321-001, wreck of Japanese warship, 23 km west of Honiara, Guadalcanal, Solomon Islands, 20–22 m, 8(11–19 mm); CAS 36929, small coral filled bay formed by a finger of Usa Island, Auluptagel Island, and Ryugu Island, 7°18'47"N, 134°29'22"E, Palau Islands, 1(22 mm); CAS 52781, type locality, cleared and stained, 1(21 mm); CAS 53329, type locality, 5(17–21 mm); LICPP 1977056, Malipano, Samal, Mindanao, Philippines, 5 m, 1(17 mm); ROM 42573, data same as AMS I. 23421-001, 76(10 – 22 mm); ROM 42575, Bonagi Island, west of Honiara, Guadalcanal, Solomon Islands, 20 m, 3(10–14 mm); ROM 42576, locality same as ROM 42575, 18–22 m, 8(11 – 19 mm); USNM 235991, Viti Levu, Fiji, 18°25'S, 178°45'W, 0–37 m, 4(11–20 mm); USNM 257055, Jalun Island, Hermit Islands, Papua New Guinea, 1°31'12"S, 145°01'30"E, 0–15 m, 1(16 mm); USNM 261553, Oriental Negros, just off Bonbonon Point, Philippines, 9°2'45"N, 123°7'37"E, 0 – 12 m, 1(22 mm); USNM 261557, Balicasag Island, Philippines, 9°31'14"N, 123°40'E, 0–25 m, 1(19 mm).

Diagnosis. Dorsal fins VI + I, 15–18 (usually I, 16–17); anal fin I, 16–17 (usually I, 16); pectoral fin 16–18; branched caudal rays 6+5; body naked; gill opening narrow, ending ventrally just below lower pectoral-fin base and below posterior quarter of operculum; gill-rakers 1–3+10–12 (=12–14); no head

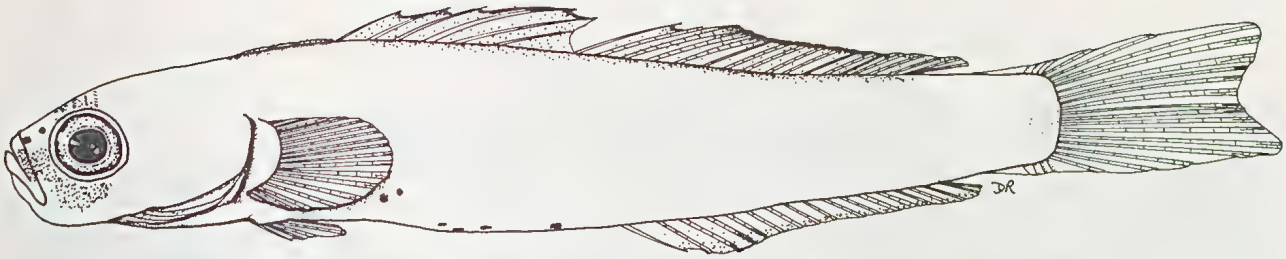

Fig. 10. *Parioglossus nudus*, holotype, female, 19.0 mm, CAS 36930, Palau Islands (body colour faded).

pores; nuchal crest usually low in both sexes, extending forward to above middle of operculum; dorsal spines 4 and 5 longest but not elongate in either sex; second dorsal and anal segmented rays 2–4 or 5 branched, rest unbranched; caudal fin forked; large spots or small, closely spaced spots present on belly.

Description. Rostral bone present; ventral postcleithrum present. Mouth inclined at angle of 65–75° to longitudinal axis of body; anterior nostril a simple pore. Dorsal spines increasing in length to spine 4, spines 4 and 5 about equal and may reach to spine of second dorsal or slightly beyond (in specimens >17 mm), spine 6 shorter than spine 5; females and males with dorsal and anal rays 2 and 3 longest, posterior rays decreasing in length; males with last ray of each fin slightly elongate not reaching to end of caudal peduncle; pectoral-fin margin round, fins less than head length; innermost and outermost pelvic rays unbranched; middle 2 rays branched in specimens over 16 mm; pelvic ray 3 longest but not prolonged in either sex.

Colour in alcohol. Body yellow; dusky patch on midside of posterior caudal peduncle extending onto bases of caudal rays 8–11 (often faded); preorbital, interorbital and suborbital dusky to black; diffuse black stripe on upper edge of preoperculum (often faded); first dorsal fin dusky; females with narrow black stripe along nuchal crest and margin of first and second dorsal fins; second dorsal and anal fins dusky, bases of dorsal and anal fins sometimes dark; base of pectoral fins dark; closely spaced, small brown spots or sometimes large, well-separated spots usually present on gut of both males and females.

Distribution. Found on coral reefs froms depths of 5 to 37 m from Fiji, Solomon Islands, Papua New Guinea, Palau Islands, and the Philippines.

Comments. *Parioglossus nudus* differs in several characters from other species in the genus. The lack of scales, head pores and distinctive pigmentation, which could be regarded as juvenile features, are maintained in mature specimens. Individuals of the species are small (the largest specimen being 21.9 mm and a female with eggs as small as 17.4 mm) relative to other members of the group. *Parioglossus nudus* is known from depths much greater than those of other species of *Parioglossus*, but it also occurs at shallower depths.

Etymology. From the Latin, *nudus* = naked, named for the lack of scales on the body.

Parioglossus palustris (Herre)

Figs 11, 25, 36

Ptereleotris microlepis evides.— Abe, 1939 (not Jordan and Hubbs): 569 (Palau Islands).

Andameleotris palustris Herre, 1945a: 2 (Zamboanga, Philippines).

Parioglossus borneensis Koumans, 1953: 363, fig. 89 (Balikpapan Bay, Borneo).— Tomiyama, 1958: 1191, pl. 231,fig. 585 (Palau Islands); Tomiyama, 1959: 102, fig. 2 (Palau Islands).

Type material. HOLOTYPE: CAS-SU 36808, from a pool in a nipa swamp near the fisheries station, Mindanao, Philippines, collected by A.W. Herre, 10 September 1940, male, 24 mm. PARATYPES: CAS-SU 36809, type locality, 3(17.9–19.5 mm). Holotype of *P. borneensis*, ZMA 110.139, Borneo, female (21.7 mm); paratype of *P. borneensis*, RMNH 17094, Borneo, female (21.3 mm).

Additional material. AMS I. 17541-003, Konedobu mangroves, Port Moresby, Papua New Guinea, 2(14–21 mm); AMS I. 22055-004, Bailey Creek, Cape Tribulation, Queensland, 1(25 mm); AMS I. 22849-002, Great Keppel Island, Queensland, 14(11–27 mm), cleared and stained, 2(23–24 mm); AMS I. 23936-002, East Arm, Darwin, Northern Territory, 125(11–28 mm); BPBM 15915, Port Moresby, Papua New Guinea, 2(21–24 mm); WAM P.28158, Bristow Island, Papua New Guinea, 6(20–28).

Diagnosis. Dorsal fins VI + I, 16–17; anal fin I, 16–18 (usually I, 17); pectoral fin 16–19 (usually 16–17); branched caudal rays usually 7+6; longitudinal scale count 78–89, scales imbricate; gill opening narrow, extending ventrally to just below lower pectoral-fin base and below posterior quarter of operculum; gill rakers 3+13–15; 5 pores along upper and rear margin of eye, and 2 preopercular pores; nuchal crest a low fold in both sexes, extending forward to above and between anterior quarter of operculum and rear end of eye; dorsal spines 3, 4 and 5 elongate in males over 20 mm; spines 2, 3 and 4 longest in females but not elongate; second dorsal and anal segmented rays 2–4 or 5 and last ray branched, rest usually unbranched; caudal fin round to slightly emarginate; no dark lateral stripe on body; dark round spot at base of ventral caudal rays.

Description. Rostral bone present; ventral postcleithrum present. Anterior extent of predorsal scales from above posterior preopercular margin, extending dorsally to nuchal crest, excluding midline; scales on body extending posteriorly onto base of caudal fin; belly, prepelvic area and pectoral-fin base scaled

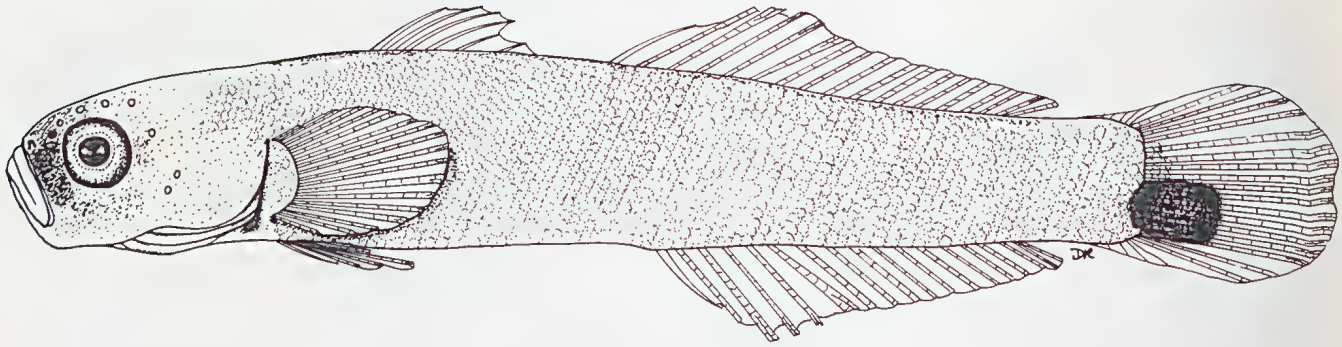

Fig. 11. *Parioglossus palustris,* female, 21 mm, AMS 1.17541-003, Papua New Guinea.

(sometimes sparsely). Mouth inclined at angle of 80–85° to longitudinal axis of body; anterior nostril a short tube; head pores: posterior nasal pore, anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore, 2 preopercular pores (not always present in specimens under 20 mm). Membrane from dorsal spine 6 not connected to base of second fin in either sex; dorsal spines 3, 4 and 5 longest in males larger than 20 mm, reaching to second dorsal origin, spine 6 reaching to second dorsal origin; spines 2–4 longest in females not reaching to second dorsal origin; females with dorsal and anal rays 2–4 longest, posterior rays decreasing in length; males larger than 20 mm with dorsal and anal rays approximately equal in length, last ray not reaching end of caudal peduncle; pectoral-fin margin oblong, fin less than head length; only innermost pelvic ray unbranched, others branched; pelvic ray 3 longest not reaching beyond tip of pectoral fin in either sex; caudal fin of females round to slightly emarginate, rays 8–9 or 10 shorter than surrounding caudal rays; rays 5–7 or 8 and 10–11 elongate in males larger than 20 mm.

Colour of fresh material. Body brown to reddish with dark black spot at base of lower caudal rays; dorsal, anal and pelvic fins reddish with white to yellowish margin; 2 reddish stripes extending to tips of upper and lower caudal rays leaving dorsal and ventral margins white to yellow; head with several red patches on cheek, interorbital and snout; blue-green iridescent rectangular spot ventral to eye; snout and operculum dusky; thin reddish lines along myomere septa on ventral half of body.

Colour in alcohol. Body brown; dark round spot at base of caudal rays 9–15; small black spots (about 13–16 pairs) sometimes present on either side of second dorsal and anal fins; dusky patch sometimes present posterior to eye just below infraorbital pore; females frequently with dark, closely spaced, small spots in 2 longitudinal rows on either side of gut; second dorsal fin dusky, upper rays of caudal fin dusky, other fins pale; anus pale to brown.

Distribution. Found in shallow waters of mangrove zones of Borneo, Philippines, Papua New Guinea, and northern Australia. This species is known from Japan (Senou, personal communications).

Comments. The distinctive caudal-fin spot and the lack of a mid-lateral stripe along the body easily distinguishes *P. palustris* from other species of *Parioglossus*. *Parioglossus palustris* has been collected with *P.* sp. but body coloration will separate the two species. Specimens of *P. raoi* under 17 mm have a large caudal-fin spot which may, at first glance, resemble that of *P. palustris*. However, *P. raoi* has a distinct black spot on the first dorsal fin and a stripe (sometimes faded) on the lateral surface of the body, markings which are not present on *P. palustris*.

Parioglossus philippinus (Herre)

Figs 12, 26, 34

Herreolus formosus (in part).— Herre, 1940: 364 (Port Holland, Basilan, Philippines).

Herreolus philippinus Herre, 1945b: 14 (Santa Maria, Zamboanga Province, Mindanao, Philippines).

Pterelеotris stigmaturus Smith, 1945: 511, Fig. 102 (Chantabun River Estuary, S.E. Thailand).

Type material. HOLOTYPE: CAS-SU 36812, Santa Maria, Zamboanga Province, Mindanao, Philippines, collected by A.W. Herre, 21 September 1940, female, 23.7 mm. PARATYPES: CAS-SU 36813, type locality, 1(20.5 mm); CAS-SU 36814, type locality, 2(23 mm). Holotype of *Pterelеotris stigmaturus*, USNM 119639, Chantabun Estuary, Thailand, male (22 mm). Paratype of *P. stigmaturus*, USNM 119640, Chantabun Estuary, Thailand, 1(22 mm).

Additional material. AMS I.24223-001, Rabaul Yacht Club, New Britain, 2(13–19 mm); BMNH 1960.8.29:6-9, Ratnagiri, Bombay, India, 4(24–25 mm); BMNH 1960.12.30:32-61, Ratnagiri, Bombay, India, 28(22–25 mm); CAS-SU 69 000, Port Holland, Basilan, Philippines, 1(30 mm); NTM S. 10004-022, Sandy Island, Coburg Peninsula, Northern Territory, 1(18 mm); USNM 261549, Pt. Fievre, Madagascar, 1(19 mm). The following material is all from the Gulf of Thailand: AMS I.24322-001, Prachuap Kiri Khan Province, west side of Goh Luem, 10(24–32 mm); AMS I.24323-001, northwest side of Goh Maprao, Chumphon Province, 8(19–30 mm); CAS 36933, Ban Angtong Bay, west side of Goh Samui Island, 3(21–23 mm); CAS 36934, Aoa Kating Bay, 4(19–22 mm); CAS 36935, south side of Goh Proet Island, 5(17–23 mm); CAS 36936, southwest shore of Ko Chang, 4(19–22 mm); CAS 36937, southeast of Ban Pae fisheries station, Rayong Province, 11(17–28 mm); CAS 36938, northwest side of Koh Samet Island, Rayong Province, 1(16

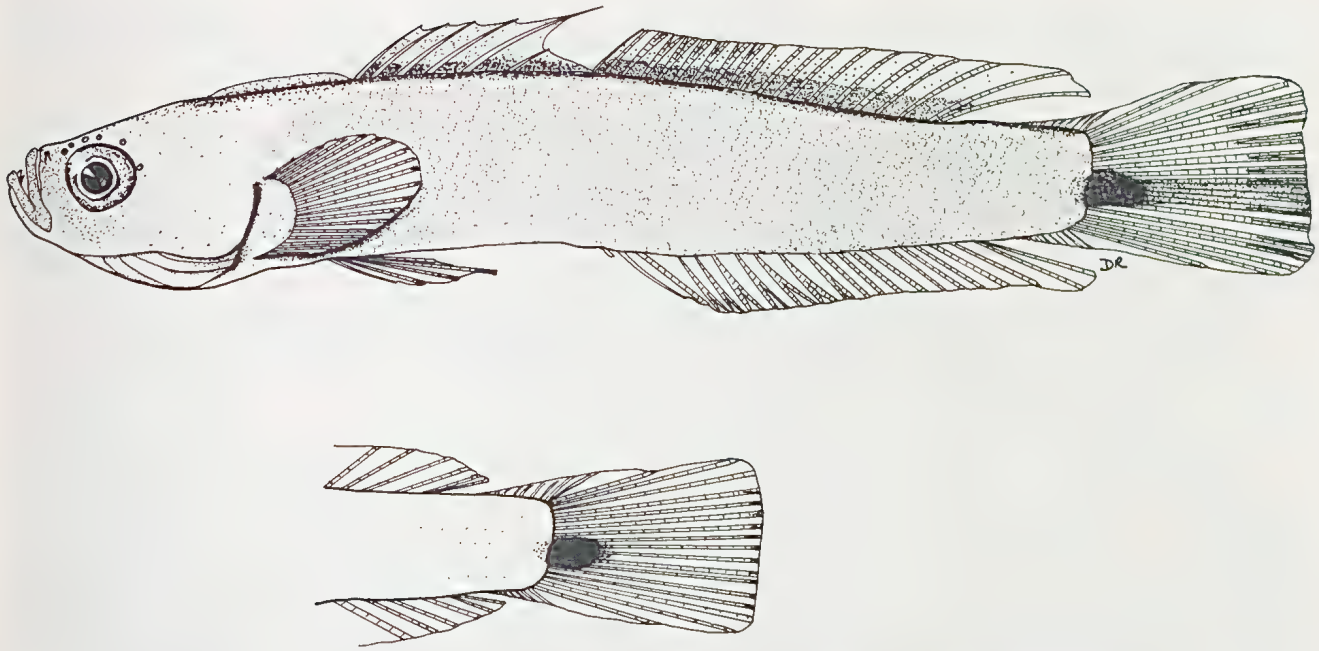

Fig. 12. *Parioglossus philippinus*, male, 32 mm, CAS 36948, Gulf of Thailand, and caudal pigment of female.

mm); CAS 36939, Ko Kroi Island, Rayong Province, 4(19–22 mm); CAS 36941, Prond Bay, southwest corner of Goh Samed, Chumphon Province, 60(15–29 mm), cleared and stained, 3(20–24 mm); CAS 36942, northwest side of Goh Maprao, Chumphon Province, 67(15–31 mm); CAS 36943, Chumphon Province, northeast end of Goh Kawtian, 2(19–26 mm); CAS 36944, southwest of Kau Larn, Chumphon Province, 3(23–28 mm); CAS 36945, southwest point on Goh Chorakhav, Chumphon Province, 9(16–24 mm); CAS 36946, north tip of Goh Chorakhav, Chumphon Province, 1(22 mm); CAS 36947, northwest side of Goh Raed, Prachuap Kiri Khan Province, 1(16 mm); CAS 36948, west side of Goh Luem, Prachuap Kiri Khan Province, 21(15–32 mm); CAS 36950, west side of Goh Luem, Prachuap Kiri Khan Province, 154(10–32 mm); CAS 36951, northwest side of Goh Raed, Prachuap Kiri Khan Province, 18(13–28 mm).

Diagnosis. Dorsal fins VI + I, 16–19 (usually I, 17–18); anal fin I, 16–19 (usually I, 17–18); pectoral fin 17–20 (usually 18–19); branched caudal rays usually 6+5 (occasionally 6+6); procurrent caudal rays 8–11+8–10; longitudinal scale count 61–81, scales nonimbricate; gill opening narrow, extending ventrally to just below lower margin of pectoral-fin base, and below and just in front of posterior opercular margin; gill rakers 2–3+12–14; 5 head pores along upper and rear margins of each eye, no preopercular pores; nuchal crest a moderate to prominent fold in males, a low fold in females, extending forward to above front quarter of operculum or to above eyes in large males; spine 5 of males over 20mm longest; all dorsal spines of females lower than anterior rays of second dorsal fin; second dorsal and anal rays 2 to 8 or 9 branched, others usually unbranched (sometimes posterior rays branched, but rarely all rays branched); caudal fin truncate to emarginate; round to elongate black spot at base of middle caudal rays; males with faint narrow grey ring around anus.

Description. Rostral cartilage not replaced by bone; ventral postcleithrum present. Anterior extent of predorsal scales from over rear of operculum, extending in straight line to below dorsal spine 2; scales on body extending posteriorly to end of caudal peduncle; no scales on back immediately below dorsal fins and on dorsal midline of caudal peduncle; belly sparsely scaled; prepelvic area and pectoral-fin base naked. Mouth inclined at angle of 75–85° to longitudinal axis of body; anterior nostril a simple pore, with slightly elevated margin; head pores: posterior nasal pore, anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore; preopercular pores absent. Membrane of dorsal spine 6 of males attached to base of spine of second dorsal fin, not attached in females; first dorsal fin low in both sexes, spine 5 of males larger than 20 mm extending to origin of second dorsal or slightly beyond; spines of females all lower than anterior rays of second dorsal fin, not reaching to second dorsal fin; dorsal and anal rays of males about equal in length from beginning to middle of fins, posterior rays increasing in length gradually, last ray of each fin extending beyond end of caudal peduncle; females with dorsal and anal rays 2–3 longest, posterior rays decreasing in length; pectoral fin margin oblong, fin shorter than head length; only innermost ray of pelvic fins unbranched, others rays branched; pelvic ray 3 elongate in males, sometimes extending to anus, only slightly longer than ray 2 in females; caudal fin truncate or emarginate, specimens larger than 20mm may have elongate dorsal and ventral caudal lobes.

Colour in alcohol. Body brown to yellow; dorsal midline from behind eyes to caudal peduncle and base of anal fin dusky to black; round to elongate black spot

on base of caudal rays 8–12, frequently extending as a stripe to tip of rays 9–11; males with basal half of dorsal fins dusky, other fins pale; females with pale fins; males with a narrow dark ring around anus (often faded); females with anus pale to brown.

Distribution. Associated with sand and coral reefs to 10 m; widespread in the southwestern Pacific and Indian Oceans from the Northern Territory (Australia), New Britain, Philippines, Gulf of Thailand, India, and Madagascar.

Comments. *Parioglossus philippinus* and *P. dotui* are very similar. There can be considerable difficulty in separating these species as there is slight overlap in some distinguishing characteristics, such as numbers of dorsal and anal rays, branched caudal rays and procurrent caudal rays, longitudinal scale counts, and branching of posterior dorsal and anal rays. Body colour of the two species is very similar. Differences between the two species include a diffuse mid-lateral stripe on body in *P. dotui* (no stripe in *P. philippinus*), a more distinct spot on the caudal fin of *P. philippinus* (the spot of *P. dotui* often extending to the tips of the fin rays), and the absence of a horizontal stripe posterior to the eye in *P. philippinus*.

The branched caudal-ray number, which is one of the most distinctive differences between the species, is occasionally 6+6 in both species. Two of the 16 specimens from the Ryukyu Islands have this number and there is the possibility that hybrids or integrades occur in the Ryukyu Islands. However, Senou (personal communication) has indicated that he has examined material of both species from the same collection from Shikoku Island, Japan. The two species differ in the width of the gill opening, with *P. dotui* having a much broader gill-opening, and at present there is no evidence that the two species overlap in this feature.

Ranade and Sankolli (1962) identified *P. philippinus* from Ratnagiri, India, as *P. taeniatus* but Miller (1971) identified it as *P. dotui*. Miller suggested the possibility of *P. philippinus* (as *P. dotui*) and *P. taeniatus* being different colour phases of the same species; however, as he also noted, morphological differences of mature males and females between the species indicate that *P. philippinus* and *P. taeniatus* are distinct. *Parioglossus taeniatus* and *P. formosus* can be distinguished from *P. philippinus* by fin-ray counts, differences in male dorsal spine lengths and the absence of preopercular pores in *P. philippinus*. The only other species that has a black anus in females is *P. marginalis* which can be distinguished from *P. philippinus* by the presence of imbricate scales, higher longitudinal scale count and differences in coloration. *Parioglossus philippinus* also resembles *P. verticalis* in meristic counts, but body coloration differs considerably.

Both *Herreolus philippinus* Herre and *Ptereleotris stigmaturus* Smith were described in 1945. *Herreolus philippinus* Herre (1945b) appears to be the oldest available name with a listed publication date of 21 March. Ernest A. Lachner has informed us that the copy of Smith (1945) in the Division of Fishes (USNM) library was date stamped 13 November upon receipt from the U.S. government printing office.

Parioglossus rainfordi McCulloch

Figs 13, 27, 37

Pariglossus (sic) *rainfordi* McCulloch, 1921: 471, pl. 61, fig. 4 (Bowen, Queensland).

Ptereleotris taeniatus rainfordi.— Abe, 1939: 569 (Palau Islands).

Herreolus formosus.— Herre, 1940: 364 (in part, Port Holland, Basilan, Philippines).

Parioglossus rainfordi.— Tomiyama, 1958: 1183, pl. 230, fig. 583 (Palau Islands); Tomiyama, 1959: 102, fig. 1 (Palau Islands).

Type material. HOLOTYPE: AMS IA.176, from bored timber, Bowen, Queensland, 20°01′S, 148°15′E, collected by E.H. Rainford, 13 April 1921, male, 35 mm. PARATYPES: AMS IA.177 type locality, 4(28–36mm).

Additional material. AMS IA.231, Bowen, Queensland, 20(21–38 mm); AMS IA.6325, Lindeman Island, Queensland, 8(30–38 mm), cleared and stained, 2(28–37 mm); AMS I.17541-004, Konedobu mangroves, Port Moresby, Papua New Guinea, 1(25 mm); AMS I.22849-001, Great Keppell Island, Queensland, 4(14–36 mm); BPBM 18614, Ambon, Moluccas, Indonesia, 1(22 mm); BPBM 28946, Port Moresby, Papua New Guinea, 2(28–32 mm); CAS 56021, Palau Islands, 3(22–23 mm); CAS-SU 33117, Port Holland, Basilan, Philippines, 2(14–31 mm); USNM 257051, Kranket Island, Papua New Guinea, 1(25 mm); USNM 257053, Negros Oriental, Philippines, 1(17 mm); USNM 260322, Ponape, Caroline Islands, 1(21 mm); USNM 261550, Kairiru swamp, Muschu Island, Papua New Guinea, 1(18 mm); USNM 262202, Basilaki Island, Papua New Guinea, 30(24–32 mm); USNM 264337, Misool, Irian Jaya, 1(27 mm); USNM 264339, Batanta Island, Irian Jaya, 7(16–25 mm).

Diagnosis. Dorsal fins V–VI + I, 14–17 (usually I, 15–16); anal fin I, 14–16 (usually I, 15); pectoral fin 16–18 (rarely 16); branched caudal rays 7+6; longitudinal scale count 90–109, scales nonimbricate or imbricate; gill opening narrow, extending ventrally to just below lower pectoral-fin base and below posterior quarter of operculum; gill rakers 3–4 + 14–15; 5 head pores above and behind each eye; 2 preopercular pores; nuchal crest a low fold in both sexes, extending forward to above operculum; dorsal spine 3 elongate to filamentous in both sexes; second dorsal- and anal-fin rays branched, except first ray of each fin often unbranched; caudal fin round to truncate; males with grey to brown vertically elongate bar at base of caudal fin rays 2–14, females and immature males with dark, roundish spot at base of caudal rays 4–12.

Description. Rostral bone present; ventral postcleithrum present. Anterior extent of predorsal scales from just above middle of operculum extending posteriorly and dorsally in line to below dorsal spine 3; scales on body extending posteriorly onto base of caudal fin, excluding area immediately below first dorsal fin; belly scaled, prepelvic area and pectoral-fin base

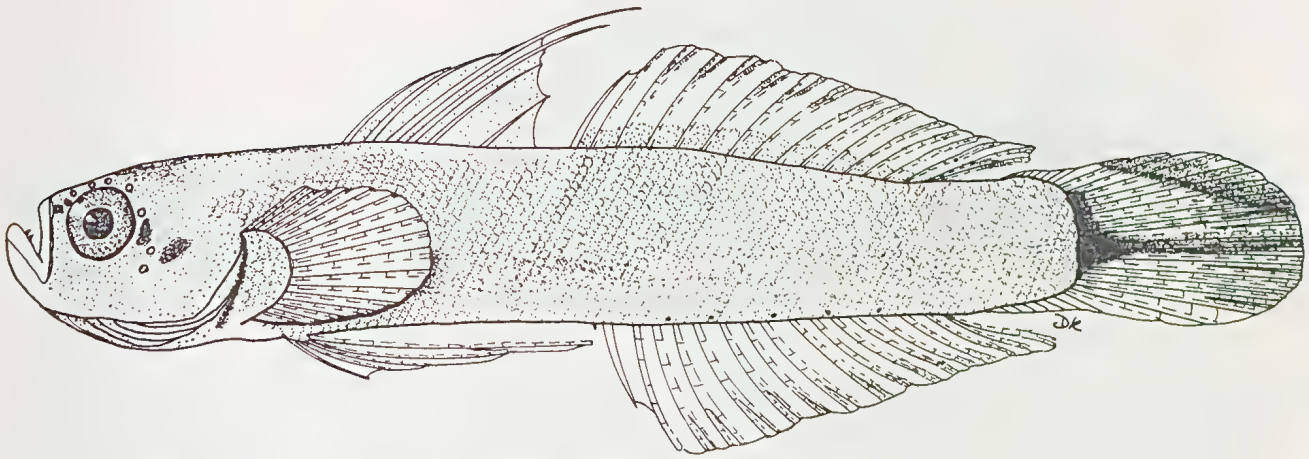

Fig. 13. *Parioglossus rainfordi*, male, 32 mm, BPBM 28946, Papua New Guinea.

naked or sparsely scaled. Mouth almost vertical, at angle of 85–90° to longitudinal axis of body; anterior nostril a simple pore, with a raised rim; head pores: posterior nasal pore, anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore, 2 preopercular pores (not always present in specimens under 19 mm). Membrane from dorsal spine 6 not attached to base of second dorsal fin; dorsal spine 3 elongate to filamentous in both sexes, reaching beyond second dorsal origin in specimens larger than 30 mm; dorsal spine 4 may be elongate to filamentous, spine 6 reaching to second dorsal origin in males; dorsal and anal rays 2 and 3 longest in females, posterior rays decreasing in length; males with dorsal and anal rays about equal in length, last rays of each fin reaching to about end of caudal peduncle or slightly anterior to end; pectoral-fin margin round, fin less than head length; only innermost pelvic ray unbranched, others branched; innermost ray of pelvic fin longest in males, reaching to anus in males over 25 mm, not elongate in females.

Colour in alcohol. Body dusky to yellow; dark grey to brown patch behind eye and similar patch on upper half of operculum; males with elongate greyish to brown vertical bar at base of caudal-fin rays 2–14, frequently with a horizontal, thin extension reaching to tip of caudal fin on rays 9–11; dark diagonal bar along upper and/or lower part of caudal fin sometimes present; females and immature males with dark grey to brown round spot at base of caudal rays 4–12; females with dusky mid-lateral stripe sometimes present (usually very diffuse) from origin of pectoral fin to about end of caudal peduncle, usually more prominent anterior to second dorsal origin; outer edge of scales often black; fins dusky to light; second dorsal fin with basal quarter of membrane dark; several pairs of small black spots on either side of anal fin.

Distribution. Found in shallow water around mangroves of northern Queensland (Australia), Papua New Guinea, Indonesia, Caroline Islands, Palau Islands and the Philippines. This species is also known from Japan (Senou, personal communication).

Comments. *Parioglossus rainfordi* is often found with *P. formosus*. The distinct mid-lateral stripe of the latter and the difference in caudal-fin coloration are distinguishing characteristics. Some confusion may occur in separating the males of *P. rainfordi* from those of *P. lineatus*, both of which have bars at the base of the caudal fin. In larger specimens, the presence of preopercular pores in *P. rainfordi* will distinguish the two species. In smaller specimens, the differences in pectoral-fin ray counts, longitudinal scale counts, size of nuchal crest and length of dorsal spine 3 will separate the two species. Herre (1940) reported 4 specimens of *P. formosus* (as *Herreolus formosus*) from Port Holland, Basilan; we have reidentified 2 of these as *P. rainfordi*. According to Herre, these fish live in the growth around pilings and swim in schools.

Parioglossus raoi (Herre)

Figs 14, 28, 36

Amblyeleotris (*Andameleotris*) *raoi* Herre, 1939: 346 (West coast, Guitar Island, Middle Andaman, Andaman Islands).

Parioglossus sp.— Hayashi, Suzuki, Ito, and Senou, 1981: 14, pl. 11, fig. 148 (Yonadagawa River, Japan).

Type material. PARATYPES: CAS-SU 37149, Guitar Island, Middle Andaman Island, collected by H.S. Rao, 22 March 1934, 17(10–16 mm).

Additional material. AMS I.23499-001, Arakawa, Ishigakijima, Japan, 3(21–25 mm); LICPP 1976017, Kabira Bay, Ishigakijima, Japan, 4(18–20 mm); LICPP 1979095, Hoshtzunanohama, Iriomotejima, Japan, 2(20–21 mm); ROM 42980, Fiji, 3(19–20 mm); ROM 42981, Fiji, 9(14–22 mm); USNM 211056, Saparua, Moluccas, Indonesia, 4(14–17 mm); USNM 223240, Ponape, Caroline Islands, 2(19–20 mm); USNM 235992, Great Astrolabe Reef, Fiji, 4(9–10 mm); USNM 236663, Viti Levu, Fiji, 1(20 mm); USNM 236664, southwest corner of Kavala Bay, Fiji, 56(8–21 mm), cleared and stained, 6(18–22 mm); USNM 257049, Siquijor Island, Philippines, 1(14 mm); USNM 257056, South Bais Bay, Oriental Negros, Philippines, 6(16–20 mm); USNM 260324, Buton Island, Indonesia, 3(8–17 mm); USNM 261546, Kumbuna Creek, Suva, Fiji, 1(18 mm); USNM 261552, Biak

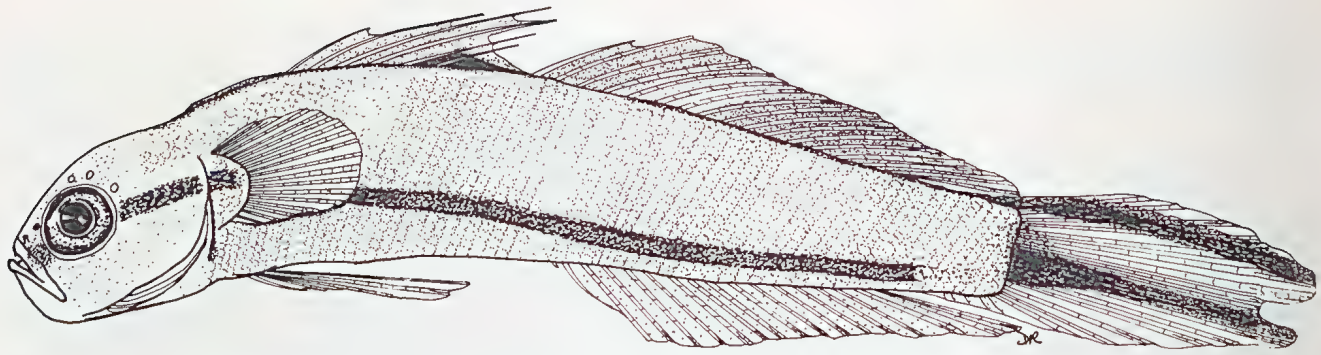

Fig. 14. *Parioglossus raoi*, male, 20 mm, USNM 223240, Caroline Islands (body arched).

Island, Schouten Island, Korido Bay, Irian Jaya, 22(10–17); USNM 264338, Misool, Irian Jaya, 1(15 mm); USNM 264340, Batanta Island, Irian Jaya, 5(13–19 mm).

Diagnosis. Dorsal fins VI + I, 14–16 (usually I, 15); anal fin I, 14–16 (usually I, 15); pectoral fin 15–18 (usually 16–17); branched caudal rays usually 7+6; longitudinal scale count 70–85, scales imbricate, occasionally nonimbricate; gill opening narrow, extending ventrally just below lower margin of pectoral-fin base and below posterior quarter of operculum; gill rakers 3–4+12–14 (=15–17); 2–6 head pores; nuchal crest a prominent fold in males, a low fold in females, extending forward to above operculum or rear of operculum; dorsal spines 3 and 4 longest in males, no spines prolonged in females; second dorsal and anal rays branched, except first ray in each fin in specimens over 20 mm, only anterior rays (excluding first ray) branched in specimens under 20 mm; inner pelvic ray elongate; caudal fin truncate to slightly emarginate in females; caudal fin emarginate in males, with dorsal and ventral lobes about equal or ventral lobe slightly longer; black stripe present from pectoral fin base to caudal peduncle, arching ventrally posteriorly and continuing just above anal fin, becoming diffuse and disappearing on caudal peduncle; width of stripe about equal to space between stripe and anal fin base.

Description. Rostral bone present; ventral postcleithrum present. Anterior extent of predorsal scales from above operculum extending posteriorly and dorsally in line to below dorsal spine 1; scales on body extending posteriorly onto caudal-fin base, excluding area immediately below first dorsal fin; belly, prepelvic area and pectoral-fin base scaled. Mouth inclined at angle of 70–75° to longitudinal axis of body; anterior nasal tube short; head pores varying from 2 to 6: 2 pores—supraocular pore, infraorbital pore; 3 pores—posterior interorbital pore, supraocular pore, infraorbital pore; 4 pores — anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore; 5 pores—posterior interorbital pore, supraocular pore, infraorbital pore, 2 preopercular pores; 6 pores—anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore, 2 preopercular pores; head pores may not be present in specimens smaller than 15 mm. Dorsal spines elongate to slightly filamentous in males, spines 3 and 4 about equal in length, extending beyond second dorsal origin, spine 5 shorter than spine 4 and longer than spine 6; no spines elongate in females, spines increasing in length to spine 3, spine 4 shorter than spine 3, none reaching second dorsal origin; dorsal and anal rays 1–4 longest in males, posterior rays decreasing slightly in length; last ray of each fin extending to posterior part of caudal peduncle or beyond; females with dorsal and anal ray 2 and 3 longest, posterior rays decreasing in length, last rays not reaching beyond caudal peduncle; pectoral-fin margin oblong, fin less than head length; only innermost pelvic ray unbranched, others branched; innermost pelvic ray longest, not reaching anus; caudal fin truncate to slightly emarginate in females, males with caudal rays 5 or 6–7 and 10 or 11–12 elongate, dorsal and ventral lobes about equal in length or lower lobe longer.

Colour of fresh material. Body yellow to brown; black stripe (width less than pupil diameter) extends posteriorly from behind eye, across body ventral to midside to tip of caudal fin; snout dusky; upper and lower caudal lobes dusky (upper darker than lower), separated by clear patch between dusky lobes and dark stripe; lateral part of belly and lower half of pectoral-fin base silver to white; ventral portion of belly dark; dorsal fins dusky to dark; large, bright blue spot between dorsal spines 5 and 6 and extending on membrane to attachment to body.

Colour in alcohol. Body brown; snout and interorbital dark; greyish to black (width less than diameter of pupil) stripe extending posteriorly from behind eye across upper operculum and pectoral-fin base, continuing on body from behind upper pectoral base (dipping ventrally under pectoral fin) along trunk and tail ventral to midside (midway between midside and anal fin to closer to anal fin) to end of anal fin where stripe frequently fades until caudal fin where stripe continues at base of caudal rays 9–14 to tips of rays 10–11 (in specimens under 16mm, caudal pigment is frequently a large, brownish spot on rays 7–15); midline of belly frequently dark; rear edge of scales often outlined in black; nuchal crest black (in Japanese specimens) or same colour as body; narrow, dusky, mid-dorsal stripe sometimes present; oblique, dusky bar across upper 7 caudal fin rays, extending to tips; oblique dusky bar sometimes present on lower caudal rays; dorsal fins dusky to dark; large black spot on membrane at base of first dorsal fin extending from dorsal spine 5 to behind dorsal spine 6; anal, pectoral, and pelvic

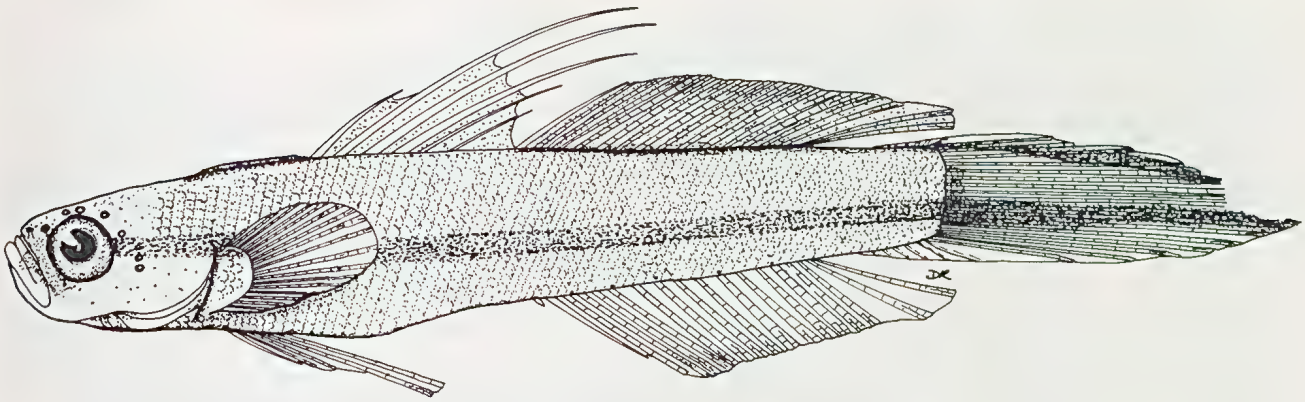

Fig. 15. *Parioglossus taeniatus*, male, 24.4 mm, AMS I.23506, Vanuatu (tail broken).

fins pale.

Distribution. Shallow water in mangroves, estuaries, and coastal marine habitats, associated with mud, sand and rock; widespread from Fiji to the Andaman Islands and from Japan to Indonesia.

Comments. Some features of *P. raoi* appear to vary with geographical location as well as with size of fish. Circumorbital pores are present in specimens over 13mm, but it is unlikely that the number of pores present at this size represents the full complement at maturity. For example, in Table 2, the greatest number of pores tends to occur in the largest specimens within each locality. At 18 mm, populations from the Caroline Islands, Fiji, Irian Jaya and the Philippines tend to have 3 pores, while those from Japan usually have 2 (Tables 1, 2). However, specimens from the Andaman Islands ranging in size between 13 and 15 mm have 3 pores. Whether 2 pores represent the average number for Japanese specimens or whether more pores develop in larger specimens is uncertain, since pores could possibly be added with increasing size. Preopercular pores are found more frequently in *P. raoi* from Fiji than elsewhere and occur in some specimens as small as 16 mm. The presence of preopercular pores will lead to some confusion in separating *P. taeniatus* from *P. raoi*; however coloration differences distinguish these species.

There is some geographic and size variation in colour. Specimens of *P. raoi* from Japan have a darker dorsal midline compared to specimens from other areas, though Herre (1939) stated that there is a narrow dark stripe on each side of the dorsal base from specimens collected from the Andaman Islands. These stripes are not present on the paratypes examined, though presumably they have faded. The large, roundish, dark spot on the caudal fin in specimens under 17 mm appears to contract in larger specimens. The smaller specimens, at first glance, resemble those of *P. palustris*, however specimens of *P. raoi*, even at 10 mm, have the distinct black spot near the end of the first dorsal fin and a lateral stripe (quite faded in many specimens), markings that are never present in *P. palustris*. *Parioglossus* sp., which has the low lateral stripe similar to that of *P. raoi* but has a more rounded fin spot compared to the elongated one of *P. raoi*, has a higher dorsal- and anal-fin ray count. Herre (1939) stated that *P. raoi* has a dorsal- and anal-fin ray count of I,15–17 and I,15–18 respectively, however, dorsal- and anal-fin counts of 10 paratypes examined were I,14–15 and I,14–16, respectively.

Some confusion might occur in distinguishing specimens of *P. raoi* from those of *P. taeniatus*. Differences in head pore counts and coloration will separate these two species; *P. taeniatus* has 4 circumorbital pores in specimens over 15 mm and *P. raoi* has the lateral stripe located more ventrally along the body and a black dorsal-fin spot.

Before the formation of the head pores, small specimens of *P. raoi* may resemble small specimens of *P. aporos*. These two species can be differentiated by the larger caudal-fin spot of *P. raoi* (fin spot of *P. raoi* on rays 5–7, while that of *P. aporos* is ventral to the midrays) and by the absence of a distinct mid-dorsal stripe in *P. raoi* (except in specimens from Japan).

Parioglossus taeniatus Regan
Figs 15, 29, 37

Parioglossus taeniatus Regan, 1912: 302 (Pacard Lagoon, Aldabra).

Type material. SYNTYPES: BMNH 1912.5.3: 28-29, Pacard Lagoon, Aldabra, collected by J.C. Fryer, 1 male, 23.1 mm, 1 female, 19.0 mm.

Additional material. AMS I.19180-016, Vei Sari River, Fiji, 1(21 mm), cleared and stained, 3(13–24 mm); AMS I.23506, Vanuatu, 1(24 mm); ANSP 64236, Suva Bay, Fiji, 1(19 mm); CAS 36926, Babelthuap Island, Palau Islands, 1(22 mm); CAS-SU 38553, Zamboanga, Mindanao, Philippines, 5(13–20 mm); ROM 42979, Fiji, 6(16-24 mm); USNM 257050, Palawan Province, Cuyo Island, Philippines, 1(12 mm); USNM 261545, Kumbuna Creek, Suva, Fiji, 1(19 mm).

Diagnosis. Dorsal fins VI + I,14–16 (usually 15); anal fin I, 15–16; pectoral fin 16–19 (rarely 19); branched caudal rays 7 + 6; longitudinal scale count 76–86, scales imbricate; gill opening narrow extending ventrally to just below lower margin of pectoral-fin base and below posterior third of operculum; gill rakers 3–4 + 13–15 (= 17–18); 4 head pores above and behind each eye and 2 preopercular pores (in specimens >19 mm); nuchal

crest a prominent fold in males, a low fold in females, extending forward to above operculum; dorsal spines 2, 3 and 4 elongate to filamentous in males; dorsal spine 3 longest in females, not prolonged; segmented dorsal- and anal-fin rays branched, except first segmented ray of each fin; caudal fin round to slightly emarginate in females, dorsal and ventral lobes elongate in males; greyish to brown lateral stripe, with dorsal edge along midline of side of body, extending along body to tip of caudal fin.

Description. Rostral bone present; ventral postcleithrum present. Anterior extent of predorsal scales from above posterior preopercular margin, extending dorsally to nuchal crest, excluding midline; scales on body extending posteriorly onto caudal-fin base (including area immediately below dorsal fins); belly, prepelvic area and pectoral-fin base scaled. Mouth inclined at angle of 70–80° to longitudinal axis of body; 4 head pores in specimens over 15 mm, 6 in specimens over 19 mm: anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore, 2 preopercular pores (in specimens >19 mm). Dorsal spines 2, 3 and 4 elongate in males, about equal in length, extending beyond second dorsal origin, spine 5 longer than spine 6, spine 1 about equal in length to spine 6; spines 1–3 of females increasing in length posteriorly, not extending to second dorsal fin, spine 4 shorter than spine 3 and longer than spine 5, spine 5 longer than spine 6; segmented dorsal and anal rays 2–3 longest in females, posterior rays decreasing in length; males with segmented dorsal and anal rays 2–4 longest, posterior rays decreasing in length, last ray of each fin longer than penultimate ray and extending beyond caudal peduncle; pectoral-fin margin oblong, fin less than head length; only innermost pelvic ray unbranched, others branched; pelvic rays 3 and 4 longest, about equal in length, not reaching anus; males with several dorsal and ventral caudal rays elongate, easily broken, ventral rays 10–13 filamentous in specimens larger than 22 mm.

Colour in alcohol. Body yellowish to brown; snout dark; brown stripe (width above anterior part of anal fin less than ½ diameter of eye) extending posteriorly from behind eye, over upper edge of operculum and pectoral-fin base, along trunk and tail (upper edge of stripe along midside) to tip of caudal fin on rays 9–14 or 15 at base and 10–11 at tips; stripe narrower than space between stripe and anal fin; diagonal bar across upper lobe of caudal fin present on rays 1–6; dorsal and ventral midlines of body and nuchal crest light; small brown to black spots often present on anal fin; dorsal fins dark, other fins dusky; females with densely spaced, small, brown spots in 2 longitudinal rows, one on either side of gut.

The syntypes of *P. taeniatus* from Aldabra are faded, and it is uncertain whether the colour described here is typical of Indian Ocean material.

Distribution. Found in areas of sand, silt and rocks in estuaries, mangroves and coastal waters of Fiji, Vanuatu, the Palau Islands, the Philippines and Aldabra.

Comments. The similarity in coloration of *P. taeniatus* with *P. formosus* and *P. raoi* has caused some confusion in past identifications, especially as these species may occur together. Of the material we have examined, which formed the basis of previous records of the species in the literature, all records (except that of the original description) have been based on other species. Differences between *P. taeniatus* and *P. formosus* include a higher fin ray count, fewer head pores and a narrower lateral stripe in *P. taeniatus*, while *P. raoi* can be distinguished by usually having fewer head pores, a lower lateral stripe, which fades on the caudal peduncle, and a black dorsal-fin spot.

Parioglossus triquetrus n. sp.

Figs 16, 30, 37

Type material. HOLOTYPE: ROM 43041, mangrove swamp in a creek 10 miles West of Lauri, Fiji, 18°14′48″S, 178°04′E, 0–1 m, collected by R. Winterbottom and R. McKinnon, 21 April 1983, male, 20.0 mm. PARATYPES: AMS I.24324-001, data as for type, 3(14–22 mm); ROM 43042, type locality, 6(11–23 mm); USNM 235990, Naikorokoro Creek about 15 km southwest of Suva, Viti Levu, Fiji, 0–1 m, 9 May 1982, 1(18 mm).

Diagnosis. Dorsal fins VI + I,15–17 (usually 16–17); anal fin I,17–18 (usually 17); pectoral fin 17–19; branched caudal rays 7+6; longitudinal scale count 83–95, scales imbricate anteriorly, occasionally nonimbricate posteriorly; gill opening moderate, extending ventrally to below middle of operculum; gill rakers 2–4 + 11–14; 5 head pores above and behind each eye, no preopercular pores; nuchal crest a low fold in both sexes, extending forward to above operculum or posterior preopercular margin; dorsal spines 2–5 filamentous in males over 20 mm; females with no prolonged spines; second dorsal and anal segmented rays branched (in specimens over 19 mm), except first segmented ray of each fin; caudal fin truncate in females, truncate in males except for rays 13–14 which are elongate in specimens larger than 18 mm; black, usually triangular spot on base of caudal rays 6–11.

Description. Anterior extent of predorsal scales from above middle of operculum extending posteriorly to below first dorsal spine; scales on body extending posteriorly onto caudal-fin base, excluding area immediately below first dorsal fin; belly and pectoral-fin base scaled; prepelvic area naked. Mouth at angle of 65–75° to longitudinal axis of body; anterior nostril a simple pore; head pores: posterior nasal pore, anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore. Dorsal spines 3–5 filamentous, in males over 20 mm spines often reaching to third quarter of second dorsal fin, spine 1 shorter than spine 2, spine 6 reaching to beyond second dorsal origin; females with spine 1 shorter than spine 2, spine 2–5 about equal, spine 6 shorter than spine 5, not

Fig. 16. *Parioglossus triquetrus*, holotype, male 20 mm, ROM 43041, Fiji.

reaching to second dorsal origin; segmented dorsal rays 2 and 3 longest, posterior rays decreasing in length; last ray of second dorsal and anal fins longer than penultimate ray and extending to base of caudal fin; pectoral-fin margin oblong, fin shorter than head length; only innermost pelvic ray unbranched, others branched; pelvic rays 3 and 4 filamentous in males, ray 3 often reaching to anus in specimens over 20 mm; no rays prolonged in females.

Colour in alcohol. Body tan; posterior edge of scales frequently black; head dusky; brown stripe on dorsal midline from snout to caudal fin (often faded); females sometimes with diffuse dusky stripe on lateral midline of trunk; first dorsal fin dusky, membrane darker between spines 5 to end; basal half of membrane of second dorsal dark in males, pale in females; basal third of membrane of anal fin dark in males, pale in females; caudal and pectoral fins dusky; black, triangular (occasionally rectangular) spot on caudal rays 6–11, highest point of triangle on ray 10 or 11; frequently with 1–2 smaller black spots just anterior to caudal spot.

Distribution. Found in mangroves of Fiji to depths of about 1.5 m.

Comments. This species is similar in coloration to females of *P. rainfordi*; however, differences such as higher fin-ray counts, lack of preopercular pores, truncated caudal fin and extremely filamentous dorsal-fin spines in males of *P. triquetrus* separate these two species.

A single 18 mm female (USNM 261547), from the Seychelles, appears close to this species. The specimen has only the anterior dorsal and anal rays branched, as in comparable sized specimens from Fiji. However, the specimen differs in having second dorsal fin I,15, anal fin I,16, a larger spot on the caudal-fin base covering bases of rays 2–12, and a thin dark stripe discernible posteriorly on the body. Otherwise the specimen agrees with the specimens from Fiji. Since it may represent a different species it is not regarded as a type.

Etymology. From the Latin, *triquetrus* = three-sided, named for the shape of the caudal-fin pigment.

Parioglossus verticalis n. sp.

Figs 17, 31, 35

Type material. HOLOTYPE: USNM 257089, north or northeast coast of Ponape, Caroline Islands, 6°57′30″N, 159°08′E or 6°59′45″N, 158°11′E (2 stations accidentally combined), 0–1.5 m, collected by V.G. Springer, 4 September 1980, male 21.4 mm.

Diagnosis. Based on one male specimen, 21.4 mm. Dorsal fins VI + I,17; anal fin I,17; pectoral fin 18; branched caudal rays 7 + 6; longitudinal scale count 103, scales imbricate; gill opening moderate, extending ventrally to below middle of operculum; gill rakers 4 + 15; 5 pores above and behind each eye; no preopercular pores; nuchal crest a low fold; no elongate dorsal-fin spines; segmented second dorsal and anal rays branched, except for first ray of each fin; caudal fin truncate; dusky to black spot at base of caudal rays 5 – 13, extending to tips of rays 8–10; black ring around anus; 13 dark vertical bands along dorsal half of body under second dorsal fin; outer half of anal fin black.

Description. Anterior extent of predorsal scales from above posterior preopercular margin extending dorsally and posteriorly in line to below dorsal spine 2; scales on body extending posteriorly onto caudal-fin base, excluding area immediately below first dorsal fin; belly scaled, prepelvic, and pectoral-fin base naked. Anterior nostril a simple pore, head pores: posterior nasal pore, anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore. No elongate spines, spines 2–6 about equal in length; last ray in second dorsal and anal fins slightly elongate, not reaching end of caudal peduncle; pectoral-fin margin oblong, fin less than head length; only innermost pelvic ray unbranched, others branched; pelvic ray 3 longest not reaching to anus.

Colour in alcohol. Body dusky; dark stripe present across snout, continuing posteriorly from eye to across operculum; stripe fades along midside of body, forming dark spot on caudal peduncle to base of caudal rays 5–13; spot extending as stripe to tips of rays 8–10; upper and lower caudal rays dark; 13 dark vertical bands along dorsal half of body, first just before second dorsal fin, last on caudal peduncle; dorsal midline dark from

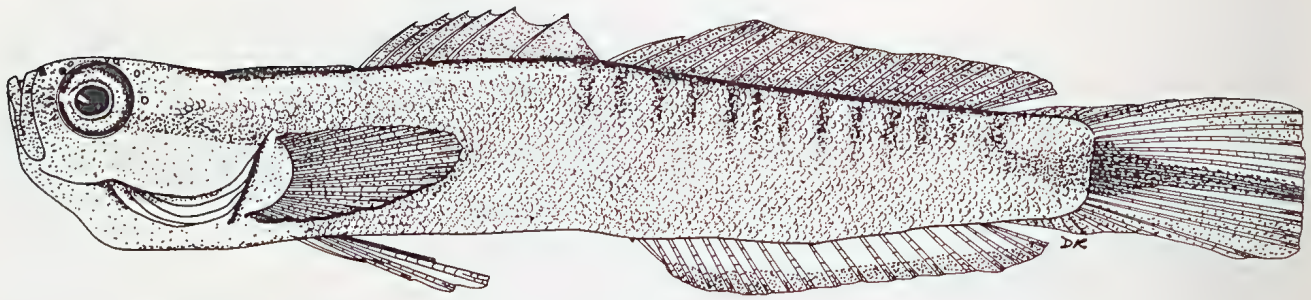

Fig. 17. *Parioglossus verticalis*, holotype, male, 21.4 mm, USNM 257089, Caroline Islands.

interorbital to end of caudal peduncle; ventral midline light; dorsal fins and pectoral fins dusky; outer half of anal fin dusky to black; narrow dark edge around anus.

Distribution. One specimen from shallow coastal water of the Caroline Islands.

Comments. Except for the vertical bands of *P. verticalis*, this species is very similar in body coloration and fin counts to *P. philippinus* and *P. dotui*. The major differences which have prompted the placement of this specimen into its own group are the higher number of longitudinal series of scales, the presence of imbricate rather than nonimbricate scales, and the vertical bands which have not been seen in any other species of *Parioglossus*.

Etymology. From the Latin, *verticalis* = upright, named for the vertical bands on the body.

Parioglossus sp.

Figs 18, 32, 33

Material examined. AMS I.17541-007, Port Moresby, Papua New Guinea, 1(20 mm); BPBM 29184, Port Moresby, Papua New Guinea, 3(16–26 mm); FO 1658, Lea Lea, Papua New Guinea, 2(22–26 mm); USNM 261551, on mainland in lee of Samei island, Irian Jaya, Indonesia, 3(20–23 mm); USNM 261554, Cape Ward Hunt, Papua New Guinea, 2(14–22 mm); USNM 261555, south coast of Misool, Irian Jaya, 1(18 mm); USNM 261556, Batanta Island, Irian Jaya, 3(17–19 mm).

Diagnosis. Dorsal fins V–VI (usually VI) + I,16–18; anal fin I,16–18; pectoral fin 16–17; branched caudal rays 7+6; longitudinal scale count 71–95, scales imbricate; gill opening narrow, extending ventrally to just below lower pectoral base and below posterior third of operculum; gill rakers 3–4+13–15 (= 16–18); usually 4 pores above and behind eyes, posterior nasal pore absent; preopercular pores present in specimens larger than 17 mm; nuchal crest a low fold in both sexes, extending forward to above operculum; dorsal spines 3 and 4 elongate in males; spine 3 longest in females but not prolonged; segmented dorsal and anal rays 2–8 branched, posterior rays unbranched, last ray usually branched in specimens over 20 mm, unbranched in smaller specimens; caudal-fin margin round to emarginate; dorsal and ventral caudal rays slightly filamentous in males; narrow brown stripe along body present below midside, extending from pectoral-fin base to about middle of second dorsal fin; width of stripe narrower than space between stripe and anal fin; round to oblong, brown to black spot at base of caudal rays 6–15 or 16; dark, diagonal bar along upper and sometimes lower caudal-fin rays.

Description. Anterior extent of predorsal scales from above posterior preopercular margin extending dorsally and posteriorly to nuchal crest, excluding predorsal midline; scales on body extending posteriorly onto base of caudal fin, excluding area immediately below first dorsal fin; belly, prepelvic area and pectoral-fin base scaled (at least in some specimens). Mouth inclined at angle of 80–85° to longitudinal axis of body; anterior nostril a short tube; 6 head pores (rarely 7, posterior nasal pore usually absent): anterior interorbital pore, posterior interorbital pore, supraocular pore, infraorbital pore, 2 preopercular pores (in specimens larger than 17 mm). Dorsal spines 3 and 4 elongate in males reaching beyond second dorsal origin, spines 2 and 5 about equal, longer than spines 1 and 6, spine 6 (when present) just reaching to base of second dorsal fin; females with spines increasing in length to third spine, spine 3 longer than spine 4, spines decreasing in length to spine 6, no spines reaching to second dorsal origin; females with dorsal and anal rays 2 and 3 longest, posterior rays decreasing in length; males with all dorsal and anal rays approximately equal in length, last ray of each fin reaching to end of caudal peduncle; pectoral-fin margin round, less than head length; only innermost pelvic ray unbranched, others branched, pelvic ray 3 longest, not reaching anus; caudal-fin margin round to emarginate, males with caudal rays 6–7 and 10–11 slightly filamentous, females with rays 5–7 slightly longer than others.

Colour in alcohol. Body yellow to brown; head dusky; upper half of pectoral-fin base dark; brown stripe extending along side of body, from pectoral-fin base to below middle of second dorsal fin, dorsal edge of stripe below midside; large, round to oblong, brown spot at base of caudal rays 6 to 13–16, sometimes extending to tips of rays 10–11 as thin stripe; brown oblique stripe present along caudal rays 1–7 and a second stripe along caudal rays 13–17 (ventral stripe

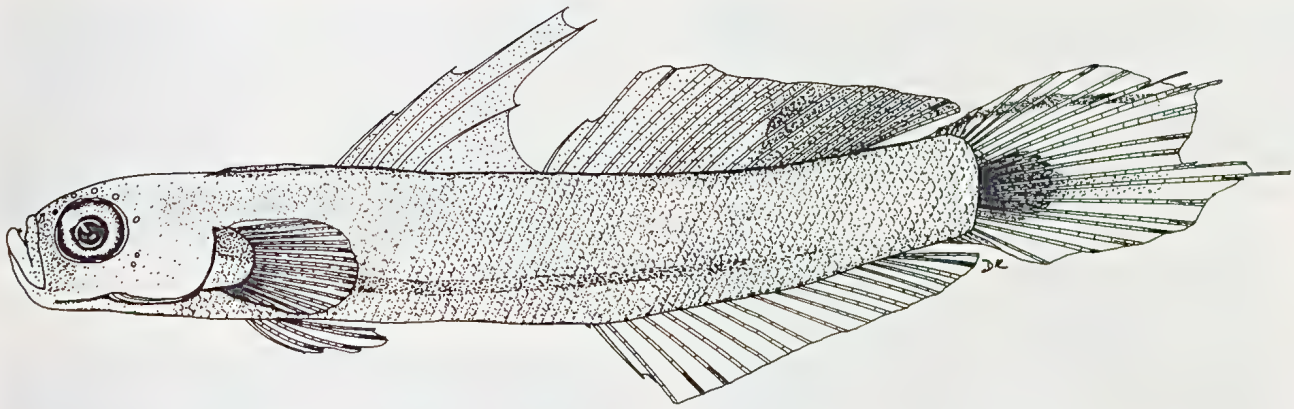

Fig. 18. *Parioglossus* sp., male, 25.6 mm, BPBM 29184, Papua New Guinea (normally 6 dorsal spines).

frequently faded); dorsal fins dusky, posterior half of second dorsal darker than anterior half; other fins pale; females with closely spaced, brown spots forming 2 longitudinal rows, one on either side of gut; 10–15 pairs of tiny black spots frequently present on body on either side of dorsal and anal fin bases.

Distribution. Shallow water in mangroves of Papua New Guinea and Irian Jaya. This species is also known from Japan (Senou, personal communciation).

Comments. This species is often found with *P. palustris*. The presence of a dark lateral stripe in *P.* sp. easily separates the two species. The low number of circumorbital pores may cause some confusion in distinguishing this species from *P. raoi* which also has a low lateral stripe; however, dorsal- and anal-fin ray counts of *P. raoi* are lower. *Parioglossus rainfordi* also inhabits mangroves of Papua New Guinea and faded specimens of *P.* sp. may be mistaken for that species, especially as both species may have 5 or 6 spines in the first dorsal fin. The lower dorsal- and anal-fin counts and 5 circumorbital pores of *P. rainfordi* are the best characteristics for distinguishing these two species.

This species will be described by Mr. Hiroshi Senou and Mr. Toshiyuki Suzuki.

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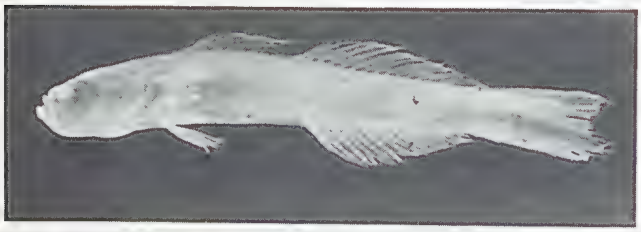

Fig. 19. *Parioglossus aporos*, holotype, male, 24.2 mm, USNM 257045, Indonesia.

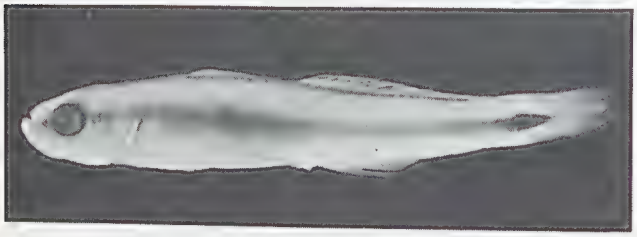

Fig. 20. *Parioglossus dotui*, female, 25.7 mm, SLMV 6037-6043, Nagasaki Prefecture, Japan.

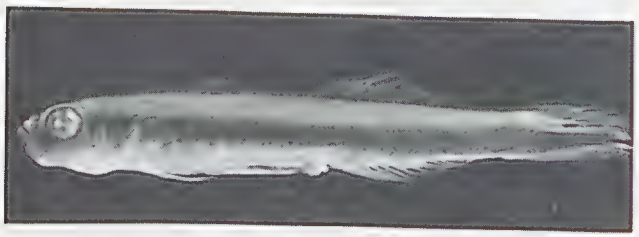

Fig. 21. *Parioglossus formosus*, female, 21.4 mm, AMS I.20392-001, Lizard Island, Australia.

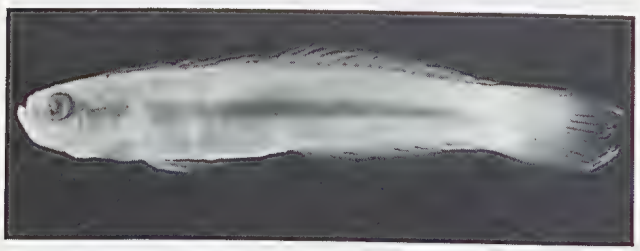

Fig. 22. *Parioglossus lineatus*, holotype, male, 33.4 mm, CAS 36928, Palau Islands.

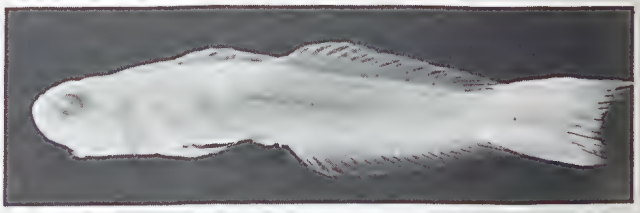

Fig. 23. *Parioglossus marginalis*, holotype, male, 35.5 mm, AMS I.17459-007, Port Hacking, New South Wales, Australia.

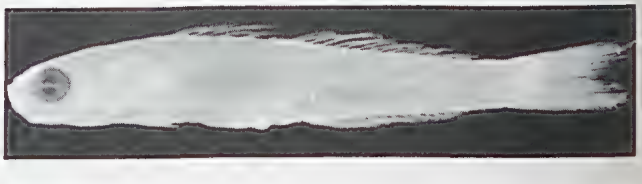

Fig. 24. *Parioglossus nudus*, holotype, female, 19.0 mm, CAS 36930, Palau Islands.

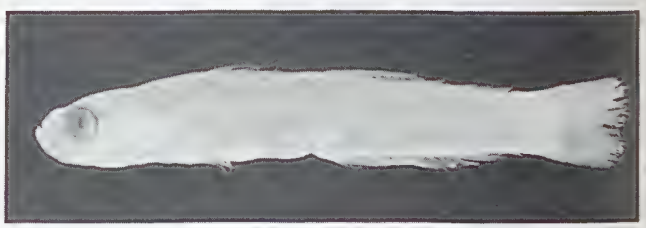

Fig. 25. *Parioglossus palustris*, paratype, male, 18.4 mm, CAS-SU 36809, Mindanao, Philippines.

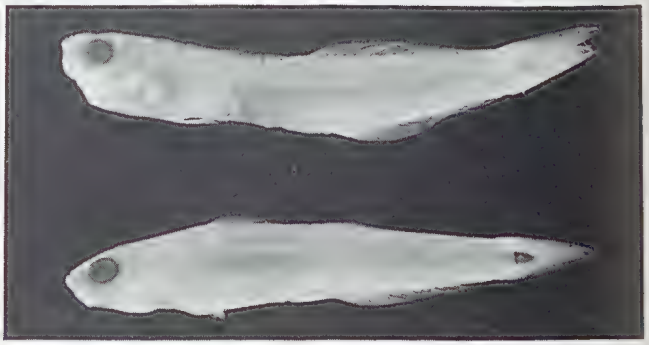

Fig. 26. *Parioglossus philippinus*, paratypes, 2 females, 23.1 and 23.8 mm, CAS-SU 36814, Mindanao, Philippines.

Fig. 27. *Parioglossus rainfordi*, male, 32 mm, BPBM 28946, Papua New Guinea.

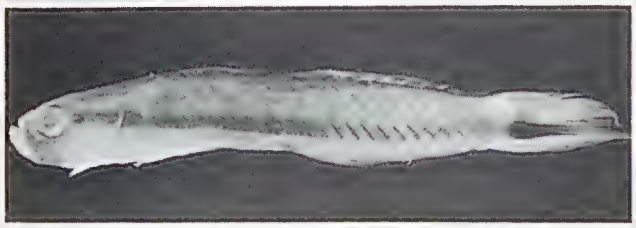

Fig. 28. *Parioglossus raoi*, male, 20.3 mm, ROM 42980, Fiji.

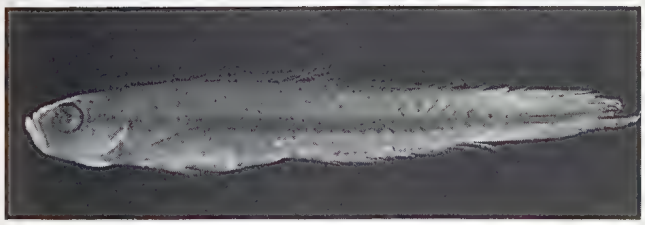

Fig. 29. *Parioglossus taeniatus*, male, 24.4 mm, AMS I. 23506, Vanuatu.

Fig. 30. *Parioglossus triquetrus*, holotype, male, 20 mm, ROM 43041, Fiji.

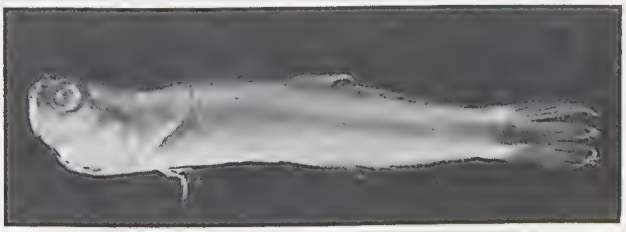

Fig. 31. *Parioglossus verticalis*, holotype, male 21.4 mm, USNM 257089, Caroline Islands.

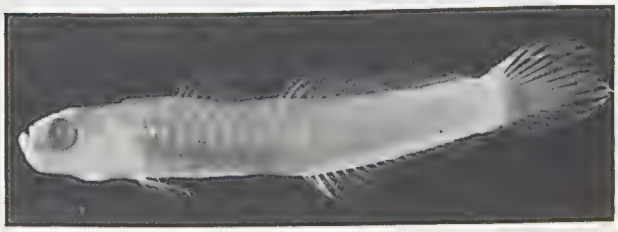

Fig. 32. *Parioglossus* sp., 25.6 mm, BPBM 29184, Papua New Guinea.

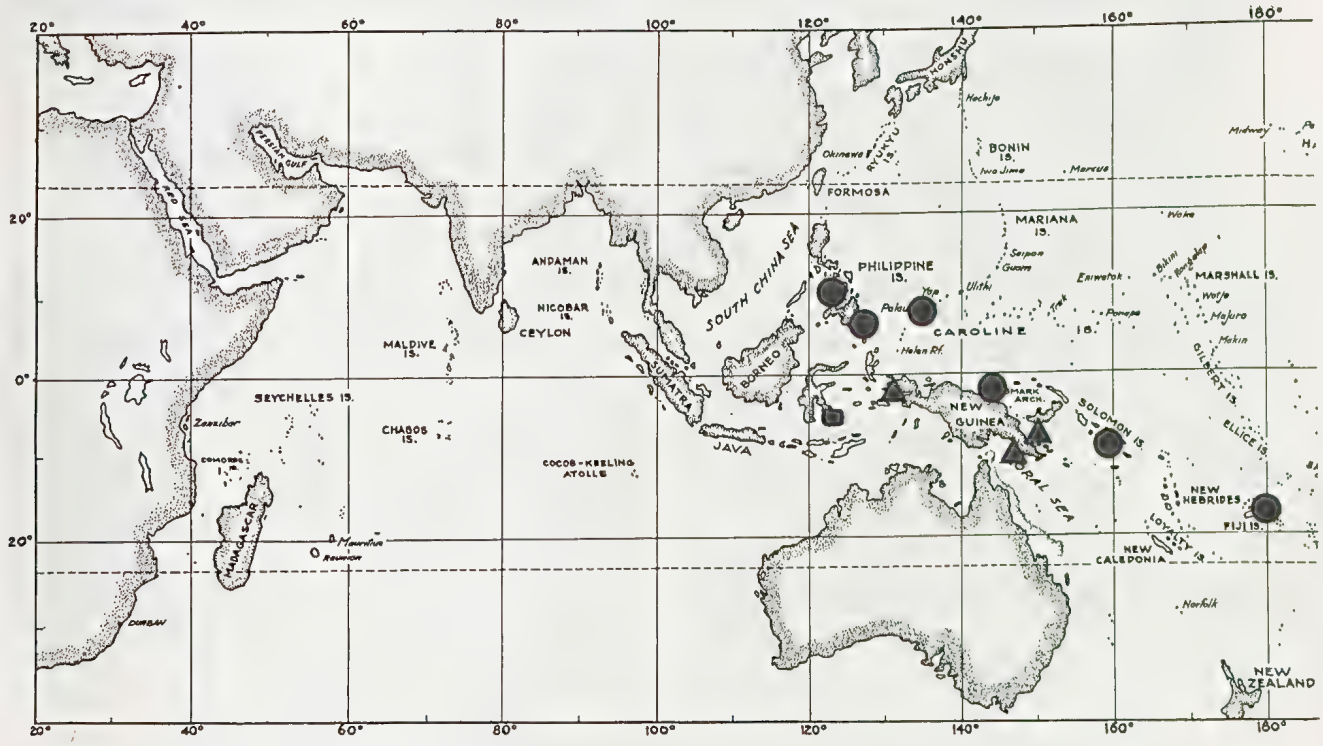

Fig. 33. Distribution of *Parioglossus aporos* (rectangles), *P. nudus* (circles), and *P.* sp. (triangles).

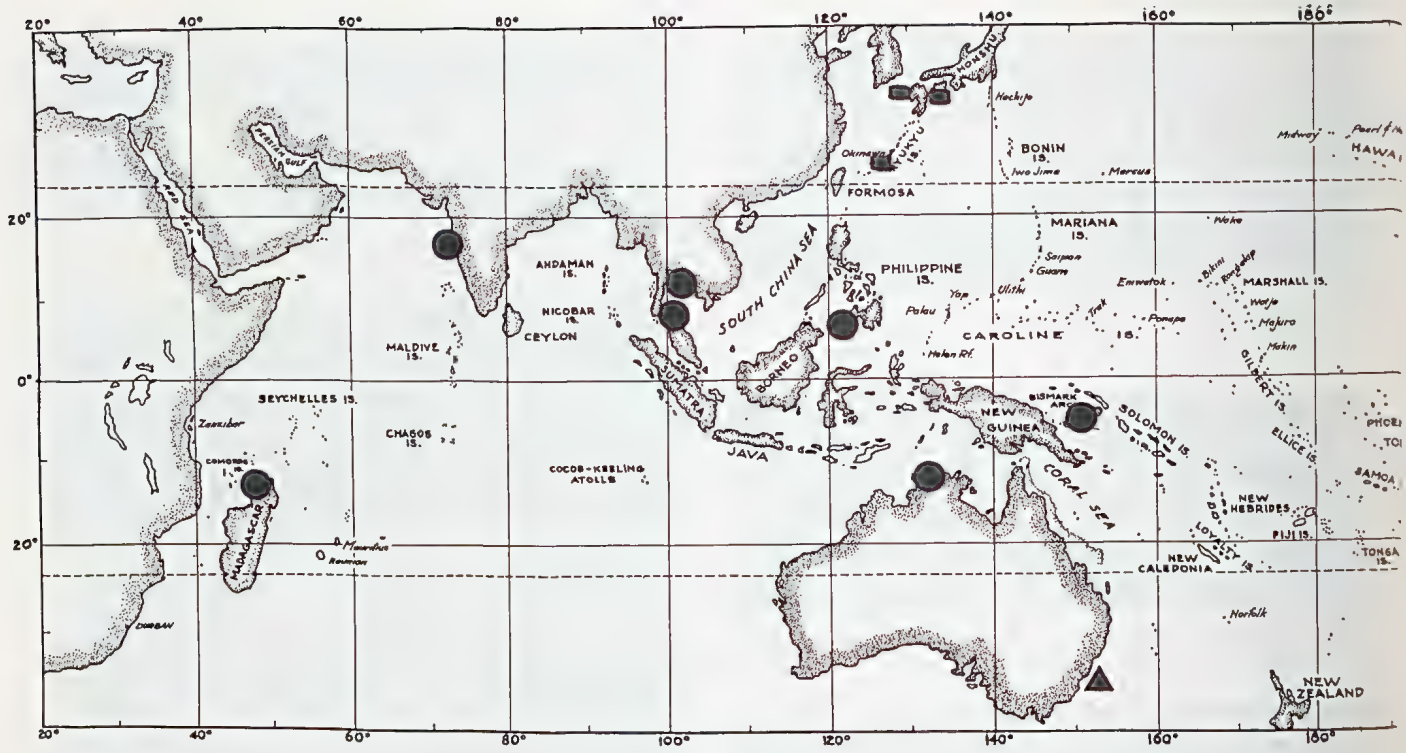

Fig. 34. Distribution of *Parioglossus dotui* (rectangles), *P. philippinus* (circles), excluding Japan as material not available to us, and *P. marginalis* (triangles).

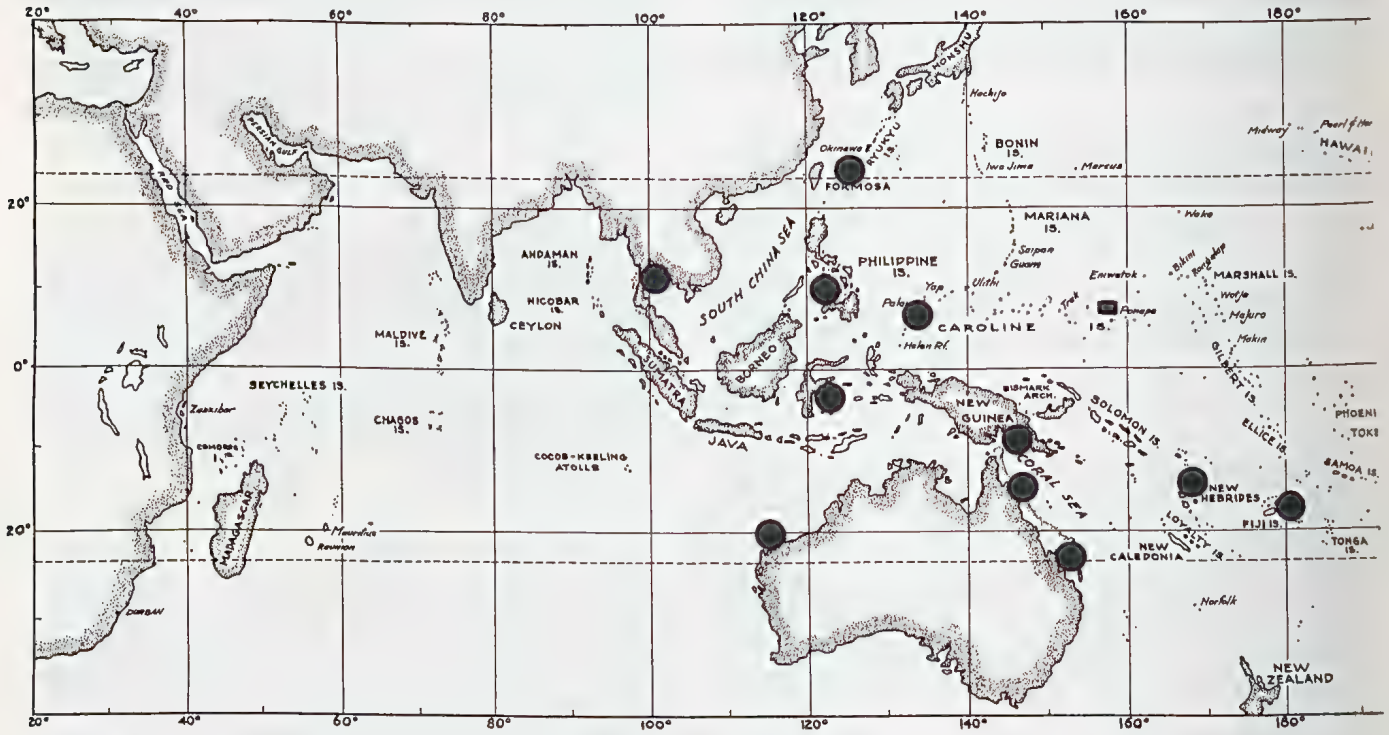

Fig. 35. Distribution of *Parioglossus formosus* (circles) and *P. verticalis* (rectangles).

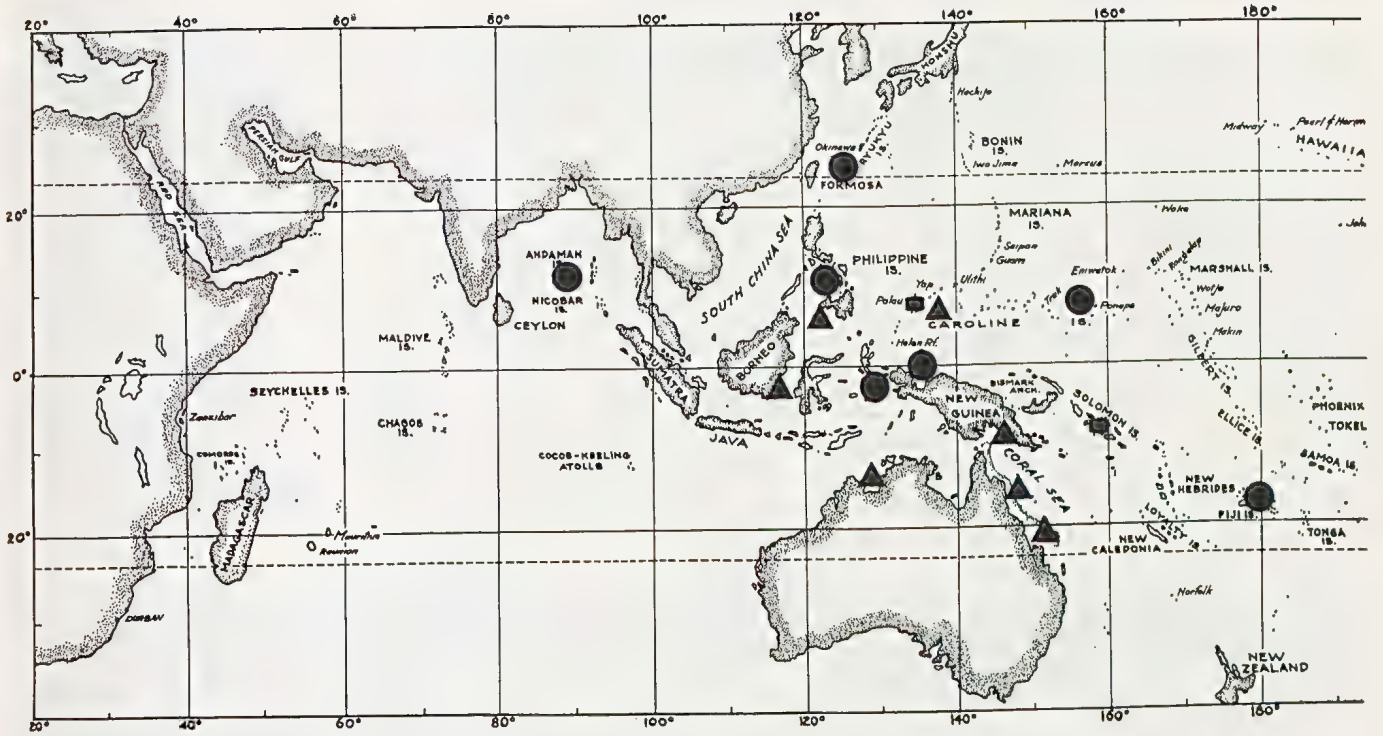

Fig. 36. Distribution of *Parioglossus lineatus* (rectangles), *P. raoi* (circles) and *P. palustris*, excluding Japan (triangles).

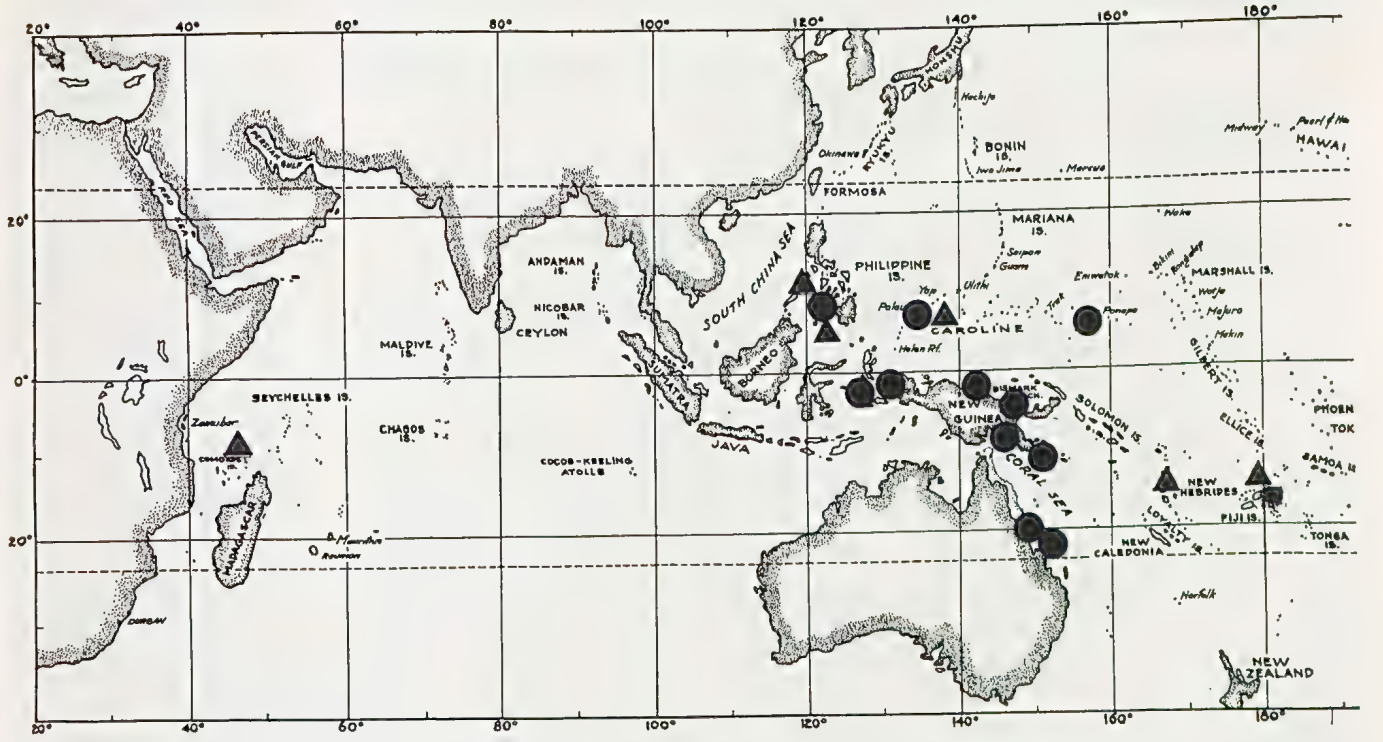

Fig. 37. Distribution of *Parioglossus rainfordi*, excluding Japan (circles), *P. triquetrus* (rectangles), and *P. taeniatus* (triangles).

Table 1. Frequency distributions of number of head pores in various populations of *P. raoi*.

Location	Average Size (mm)	Circumorbital Pores				Preopercular Pores	
		0	2	3	4	0	2
Andaman Islands	12.5	2	4	3		9	0
Caroline Islands	18.4			2		2	0
Fiji	17.5	2	4	21	5	20	12
Irian Jaya	15.4	1	6	8		15	0
Japan	18.7	4	4	1		9	0
Moluccas	14.9	3		1		4	0
Philippines	17.5		3	4		6	1

Table 2. Frequency distributions of number of head pores in *P. raoi*, in relation to fish length and geographical locality (pore number: 5 pores = 3 circumorbital and 2 preopercular pores, 6 pores = 4 circumorbital and 2 preopercular pores).

Head Pores	Standard Length in mm													
	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Andaman Islands														
0	2													
2			1	3										
3				1	1	1								
Caroline Islands														
3									1	1				
Fiji														
0		1	1	1	1									
2					2									
3						1	1	7	2	1	1	1		
5									1	1	3	1	1	
6							1		1	1	1		1	
Irian Jaya														
0				1										
2				1	2		3							
3						3	2	1	1	1				
Japan														
0							2	2						
2											2	1		1
3											1			
Moluccas														
0					2	1								
3						1								
Philippines														
2					1		1	1						
3									1	1		1		
5									1					

Table 3. Comparison of some characters of *Parioglossus* species (F, female; I, imbricate; M, male; NI, nonimbricate).

Species	Circum-orbital Pores (>15 mm)	Elongated Dorsal Spine	Caudal Pigment	Lateral Stripe	Anal Pigment	Gill Opening	Scales	Posterior Branched Dorsal/ anal Rays (excluding last ray)	Mouth Angle (degrees)	Nuchal Crest	Pre-opercular Pores (>20 mm)	Anterior Nostril Tube
P. aporos	0	3–5 (M) none (F)	stripe	diffuse	pale	moderate	NI	branched (>21 mm)	60–70	low	0	absent
P. dotui	5	none	spot	diffuse	dark ring (M) black (F)	moderate	NI	branched (>22 mm)	60–70	low	0	present (short)
P. formosus	5	3,4 (M) none (F)	stripe	present	pale	narrow	NI	branched	55–60	prominent	2	present
P. lineatus	5	4,5 (M,F)	bar	present	pale	narrow	NI	branched	65–75	prominent (M) low (F)	0	absent
P. marginalis	5	5 (M) none (F)	stripe (M) bars (F)	diffuse	pale (M) black (F)	moderate	NI, I	branched	60–70	prominent	0	present
P. nudus	0	none	none	absent	pale	narrow	—	unbranched	67–75	low–moderate	0	absent
P. palustris	5	3–5 (M) none (F)	spot	absent	pale to lightly spotted	narrow	I	unbranched	80–85	low	2	present
P. philippinus	5	5 (M) none (F)	spot	absent	dark ring (M) pale to lightly spotted (F)	narrow	NI	unbranched	75–85	prominent (M) low (F)	0	absent
P. rainfordi	5	3 (M,F)	bar (M) spot (F)	absent—sometimes diffuse	pale	narrow	NI, I	branched	85–90	low	2	absent
P. raoi	2–4	3,4 (M) none (F)	stripe	present	pale	narrow	I	branched	70–75	prominent (M) low (F)	0–2	present
P. taeniatus	4	2–4 (M) none (F)	stripe	present	pale	narrow	I	branched	70–80	prominent (M) low (F)	2	present
P. triquetrus	5	3–5 (M) none (F)	spot	absent (M) diffuse (F)	pale	moderate	NI, I	branched (>19 mm)	65–75	low	0	absent
P. verticalis	5	none (M)	spot (M)	diffuse (M)	dark ring (M)	moderate	I	branched	—	low (M)	0	absent
P. sp.	4	3,4 (M) none (F)	spot	present	pale to lightly spotted	narrow	I	unbranched	80–85	low	2	present

Table 4. Measurements of the holotypes (exception: paratype of *P. raoi* and syntype of *P. taeniatus*) of *Parioglossus* species (in mm).

Character	*P. aporos*	*P. formosus*	*P. lineatus*	*P. marginalis*	*P. nudus*	*P. palustris*	*P. philippinus*	*P. rainfordi*	*P. raoi*	*P. taeniatus*	*P. triquetrus*	*P. verticalis*
Sex	M	M	M	M	F	M	F	M	M	M	M	M
Standard length	24.2	23.5	33.4	35.5	19.0	24.0	23.7	35.0	13.0	23.1	20.0	21.4
Head length	5.7	5.2	7.2	7.0	4.2	5.0	5.1	7.2	3.4	4.9	4.4	5.2
Head width	2.6	—	3.8	4.2	1.3	—	—	3.8	1.7	2.1	2.1	3.0
Body depth	3.7	—	5.9	6.0	2.5	—	—	6.5	2.1	3.5	3.1	3.7
Predorsal length	7.8	—	10.0	10.4	5.9	—	—	10.9	4.7	7.8	6.6	6.6
Mouth	2.1	—	3.3	2.9	1.5	—	—	2.8	1.2	2.2	1.8	2.2
Eye	1.7	—	2.2	2.1	1.4	—	—	2.4	1.3	1.7	1.6	1.7
Snout	1.0	—	1.5	1.5	.7	—	—	1.2	.5	.8	.7	.8
Caudal peduncle length	3.4	—	3.8	3.3	2.5	—	—	4.8	1.6	3.4	2.1	2.8
Caudal peduncle depth	2.5	—	4.0	3.8	1.7	—	—	4.2	1.4	2.2	2.1	2.2
Pectoral fin length	4.4	—	5.7	6.6	3.3	—	—	5.7	2.4	3.7	3.5	3.8
Pelvic fin length	3.9	—	6.3	6.4	2.1	—	—	9.0	1.6	3.9	3.4	3.4
Caudal fin length	5.7	—	8.0	9.7	4.3	—	—	7.9	—	4.3	5.8	4.5
Third dorsal spine length	4.5	—	5.0	3.1	2.1	—	—	7.4	—	3.3	4.4	2.1

Table 5. Standard lengths (mm) and

Character	*P. aporos*
Standard length (mean length)	13.0–24.2 (20.0)
Head length	24.5–26.2 (13–16 mm) 22.4–23.6 (21–24 mm)
Head width	8.5–11.7
Body depth	14.8–17.4
Predorsal length	34.8–35.4 (13–16 mm) 32.2–33.8 (21–24 mm)
Mouth	7.6–9.2
Eye	7.0–9.2
Snout	3.2–4.6
Caudal peduncle length	13.5–15.6
Caudal peduncle depth	8.5–10.8
Pectoral fin length	17.4–19.2
Pelvic fin length	13.2–16.1
Caudal fin length	20.1–23.6
Third dorsal spine length	11.4–13.2 (females) 14.0–18.6 (males)

Character	*P. philippinus*
Standard length (mean length)	16.4–31.6 (23.4)
Head length	23.5–26.0 (16–20 mm) 18.7–25.4 (21–32 mm)
Head width	8.9–14.8
Body depth	12.3–17.9
Predorsal length	28.6–35.9
Mouth	7.0–8.9
Eye	6.2–8.8
Snout	3.1–5.0
Caudal peduncle length	8.4–13.1
Caudal peduncle depth	8.1–12.0
Pectoral fin length	15.3–19.4
Pelvic fin length	10.1–15.0 (females) 13.3–28.3 (males)
Caudal fin length	18.1–21.9
Third dorsal spine length	7.4–10.0 (females) 7.1–12.7 (males)

morphometric proportions (percent of S.L.) for species of *Parioglossus*.

P. dotui	*P. formosus*	*P. lineatus*	*P. marginalis*	*P. nudus*	*P. palustris*
15.9–28.7 (23.4)	11.0–35.1 (21.5)	24.7–33.4 (26.6)	27.0–39.0 (33.8)	12.9–21.9 (17.3)	13.2–28.1 (20.1)
24.0–26.4 (16–20 mm) 21.3–25.1 (21–29 mm)	21.9–26.7 (11–16 mm) 19.1–24.2 (20–35 mm)	20.8–23.5	18.9–23.4	21.9–25.9	21.5–26.5 (13–20 mm) 19.6–22.4 (21–28 mm)
9.6–12.6	9.2–14.6	11.4–13.4	9.6–13.0	9.0–13.7	10.0–12.9
14.8–18.1	14.3–19.2	16.2–19.1	16.6–20.0	12.5–16.8	13.2–17.3
31.4–34.7	33.1–38.4 (11–16 mm) 30.5–36.1 (20–35 mm)	29.9–33.9	28.1–34.0	30.0–36.0	32.3–36.4 (13–20 mm) 29.9–33.3 (21–28 mm)
7.0–10.1	7.1–9.6	8.8–10.1	7.6–9.6	6.7–9.7	7.0–9.6
7.8–10.1 (16–20 mm) 6.7–8.6 (21–29 mm)	7.5–10.6	6.6–7.6	5.4–7.3	6.7–9.5	7.9–9.9 (13–20 mm) 6.8–7.8 (21–28 mm)
3.1–5.7	2.4–5.0	4.0–4.6	3.0–4.4	3.0–5.0	3.0–4.9
10.1–13.5	12.7–16.9	11.4–13.4	8.2–10.6	10.2–14.0	8.8–11.6
9.3–11.5	8.6–11.6	11.2–12.0	9.4–12.5	7.7–11.5	9.5–12.1
16.2–19.5	14.5–17.3	17.1–18.8	16.1–18.6	15.3–18.5	15.1–20.3 (13–20 mm) 14.2–18.4 (21–28 mm)
13.1–17.2	10.4–14.3 (females) 12.4–19.9 (males)	17.1–18.9	12.0–14.6 (females) 16.4–22.7 (males)	8.6–14.1	12.4–16.5 (13–20 mm) 11.5–14.4 (21–28 mm)
17.8–24.5	13.1–22.8 (females) 22.6–37.1 (males)	19.8–19.9 (females) 22.8–24.0 (males)	17.4–19.3 (females) 18.4–27.3 (males)	19.5–25.8	12.5–20.8 (females) 10.6–18.6 (males 13–19 mm) 20.5–23.7 (males 20–28 mm)
7.0–11.6	9.0–14.4 (females) 15.0–21.2 (males)	10.1–12.7 (females) 13.2–15.0 (males)	6.4–9.7 (females) 8.2–11.6 (males)	7.1–11.2 (13–18 mm) 9.0–14.7 (19–22 mm)	10.0–12.5 (females) 12.3–14.5 (males)

P. rainfordi	*P. raoi*	*P. taeniatus*	*P. triquetrus*	*P.* sp.
21.0–36.6 (29.0)	12.9–23.0 (19.0)	16.4–24.4 (21.9)	18.0–23.1 (19.9)	14.2–26.0 (20.9)
19.7–24.5	23.6–26.4 (13–17 mm) 21.9–25.0 (18–23 mm)	27.8 (16.4 mm) 21.7–25.0 (19–24 mm)	22.0–26.4	21.5–24.5
9.5–13.4	7.9–13.2	8.6–14.7	10.0–13.5	9.4–12.7
14.1–18.6	14.0–17.7	15.8–19.6	15.5–18.5	13.8–16.9
31.1–34.2	34.5–36.4 (13–17 mm) 27.3–34.5 (18–23 mm)	32.0–35.3	31.7–34.1	29.2–34.9
7.9–9.7	7.6–10.3	7.7–10.4	8.7–9.0	7.4–9.9
6.5–8.9	7.4–10.1	7.4–10.4	7.7–9.3	7.3–10.6
2.6–4.2	3.1–4.7	3.3–4.7	3.5–4.9	3.1–4.5
12.3–16.3	10.3–14.2	11.9–14.5	9.4–11.4	10.8–14.2
10.8–13.2	8.1–11.8	9.8–12.3	9.2–10.9	10.0–11.8
14.1–18.3	15.5–19.6	15.0–18.8	17.5–21.7	14.8–17.4
12.7–17.9 (females) 15.1–29.2 (males)	13.3–15.8 (females) 17.1–23.2 (males)	13.7–16.7 (females) 18.0–27.5 (males)	12.6–15.0 (females) 17.0–28.6 (males)	10.8–16.4
19.6–26.1	17.4–23.6 (females) 22.0–36.0 (males)	21.0–24.1 (females) 37.7–42.5 (males)	18.7–19.5 (females) 23.9–29.0 (males)	17.6–18.9 (females) 21.2–27.0 (males)
8.8–16.4 (females, 21–27 mm) 20.0–24.9 females, 31–33 mm) 13.8–21.2 (males, 21–30 mm) 21.1–32.0 (males, 31–37 mm)	10.3–15.8 (females) 16.4–29.1 (males)	10.7–16.7 (females) 25.9–37.5 (males)	9.2–10.2 (females) 14.7–43.3 (males)	9.8–12.3 (females) 16.9–26.2 (males)

Table 6. Dorsal and anal fin element counts for species of *Parioglossus* (* indicates holotype count, paratype for *P. raoi* and syntype for *P. taeniatus*).

Species	First Dorsal Fin		Second Dorsal Fin							Anal Fin						
	V	VI	I,13	I,14	I,15	I,16	I,17	I,18	I,19	I,13	I,14	I,15	I,16	I,17	I,18	I,19
P. aporos		10*	5	11	2*					7	11*					
P. dotui		23				12	11						9	11	3	
P. formosus	1	25*	1	24*	6					1*	24	5				
P. lineatus		5*			3*	2						1	4*			
P. marginalis	1	20*				1	11	9*						8	13*	
P. nudus		23*			1	13*	8	1					18*	3		
P. palustris		18*				13*	8						3	17*	1	
P. philippinus		48*				5*	23	37	6				6	30*	30	2
P. rainfordi	13*	22		4	23	7*	1				5	26*	3			
P. raoi		29*		4	26*	1					3	26*	2			
P. taeniatus		13*		2	16	1*						12*	7			
P. triquetrus		8*			1	2	5*							7*	1	
P. verticalis		1*					1*							1*		
P. sp.	1	14				2	9	4					2	9	4	

Table 7. Pectoral and caudal fin ray counts for species of *Parioglossus* (* indicates holotype count, paratype for *P. raoi*, syntype for *P. taeniatus*).

Species	Segmented Caudal Rays			Branched Caudal Rays					Pectoral Fin Rays					
	8+7	9+7	9+8	6+5	6+6	7+5	7+6	7+7	15	16	17	18	19	20
P. aporos			7*				7*		8*	3				
P. dotui			25		3	1	21					12	5	1
P. formosus	2		20*				26*		2	5*	13			
P. lineatus			5*				5*					1	2*	2
P. marginalis			16*				20*				1	13*	5	
P. nudus			23*	23*						5	10	6*		
P. palustris			22*	1	1		21*	1		7	14	2	1*	
P. philippinus		1	64*	63*	3	1					3	21	14*	1
P. rainfordi			35*				35*			4	15	10*		
P. raoi			27*			2	20		1	12	8*	2		
P. taeniatus			13*				13*			7*	4	2	1	
P. triquetrus		1*	8				8*				1	4	3*	
P. verticalis			1*				1*					1*		
P. sp.			12				12			4	9			

Table 8. Procurrent caudal fin ray counts for species of *Parioglossus*.

Species	7+6	7+7	8+7	8+8	8+9	9+8	9+9	10+9	10+10	11+10
P. aporos			1	1		1				
P. dotui	7		5	1		4				
P. formosus	4	4	5							
P. lineatus			1	3		1				
P. marginalis			7	1		12				
P. nudus				1						
P. palustris	4	2	3							
P. philippinus				5		4	4	12	4	1
P. rainfordi	1	6	2	12	1					
P. raoi			4	2						
P. taeniatus	2	2	8			1				
P. verticalis		1								
P. sp.	1	1	2							

Table 9. Longitudinal scale counts of *Parioglossus* species (* indicates holotype).

Species	0	61–65	66–70	71–75	76–80	81–85	86–90	91–95	96–100	101–105	106–110
P. aporos		4*	3	1							
P. dotui				1	6	6	4				
P. formosus			1	7	4						
P. lineatus				2	2*	1					
P. marginalis							3*	5	7	1	
P. nudus	13*										
P. palustris					5*	5	3				
P. philippinus		2	11	3		1					
P. rainfordi							1	2	2	5*	4
P. raoi			1	5	7	2					
P. taeniatus					3	8	1				
P. triquetrus						3	3*	2			
P. verticalis										1*	
P. sp.				3	3		3	1			

Table 10. Total gill raker counts on outer face of first arch for species of *Parioglossus* (* indicates holotype).

Species	Gill Rakers								
	12	13	14	15	16	17	18	19	20
P. aporos	1	3	1	3*					
P. dotui					2	11	4	2	
P. formosus				4	4	2	2		
P. lineatus							1	2	1*
P. marginalis						4*	5	4	
P. nudus	1	8	6*						
P. palustris					3	9	1		
P. philippinus			1	8	10	3			
P. rainfordi						9	3	2	
P. raoi				1	5	2			
P. taeniatus						1	5		
P. triquetrus		1	2*	3		2			
P. verticalis								1*	
P. sp.					3	5	3		

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NATURAL HISTORY

The Australian Genera of Heleomyzidae (Diptera: Schizophora) and a Reclassification of the Family into Tribes

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ABSTRACT. The 16 Australian genera of Heleomyzidae are characterised, five genera, together with their type-species, being described as new. A key to the Australasian genera is given.

The classification of the Heleomyzidae is discussed and the family is defined to include the following families recognized by some recent authors: Borboropsidae, Chiropteromyzidae, Cnemospathidae, Heteromyzidae, Notomyzidae, Rhinotoridae, Trixoscelididae. The living genera of Heleomyzidae (about 65, but additional genera recognized by some) are classified into 22 tribes of which 12 are newly described. The geographic distribution patterns of the tribes are given. A new genus and species from Chile is described. A key to the neotropical genera and a partial key to the palearctic genera are appended.

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KEYWORDS: taxonomy, Diptera, Heleomyzidae, world tribes, Australian genera, neotropical genera, zoogeography.

Contents

Introduction 204
Key to Australasian genera 204
The Australian Genera 206
List of Australian species 215
Australian species erroneously referred to heleomyzid genera 215
Classification 216
List of characters typical of Heleomyzidae 217
Some structures of taxonomic importance 217
List of tribes and genera of Heleomyzidae 220
Nomenclatural notes 221
Key to tribes of Heleomyzidae 221
Descriptions of tribes 223
Geographic distribution 236
Acknowledgements 237
References 237
Appendix 1. A new neotropical genus 239
Appendix 2. Key to neotropical genera 239
Appendix 3. Partial key to palearctic genera 241
Appendix 4. List of new names, synonymy, and combinations 242
Index to taxa 250

The first modern systematic treatment of the Heleomyzidae is that of Czerny (1924). This work was written when the south-temperate fauna was almost unknown, and it covers few genera outside the tribes Heleomyzini and Suilliini. The later review of the palearctic Heleomyzidae (Czerny, 1927a) follows Malloch in adding *Trixoscelis* to the family. Malloch (1933) covered the Heleomyzidae of temperate South America. Hennig (1969) gave further information on this fauna, and Gill (1968) listed the neotropical forms, with the exception of the higher rhinotorines, which were listed by Papavero (1972). Gill (1962) treated part of the North American Heleomyzidae. Harrison (1959) treated the New Zealand forms, and Cogan (1971) the African forms.

There has been no comprehensive review or listing of the Australian Heleomyzidae. Certain Australian genera are treated by McAlpine (1967, 1968) and McAlpine & Kent (1982).

There are about 67 Australian species of Heleomyzidae available to me in collections, of which 48 are described with publication of the present work. It is an aim of this work to characterise the 16 genera in which these species are placed.

It is, further, my aim to set forth conclusions, resulting from some years' study of heleomyzid genera of the world, in the form of a reclassification showing the apparent relationships between genera. In this connection I have examined representatives of all world genera except *Porsenus* and several of the tribe Heleomyzini. As I have made a broadly based study of neotropical heleomyzids, I append a key for their generic identification. Because the non-heleomyzine genera of the palearctic region need clarification, I also give a key to these.

The morphological terminology is that used by me previously (McAlpine, 1973). Some special terminology will be explained below.

Names of institutions housing material examined are abbreviated as follows:

AM	Australian Museum, Sydney.
ANIC	Australian National Insect Collection, Canberra.
BM	British Museum (Natural History), London.
CNC	Canadian National Collection, Agriculture Canada, Ottawa.
MNM	Hungarian National Museum, Budapest.
PM	Muséum National d'Histoire Naturelle, Paris.
SPHTM	Commonwealth Institute of Health, University of Sydney, Sydney.
USNM	National Museum of Natural History, Washington, D.C.

Key to Australasian Genera of Heleomyzidae

1. Mesopleural bristle strongly developed; 3 strong reclinate fronto-orbital bristles present. 2

——Mesopleural bristle absent or weak; 1 or 2 fronto-orbital bristles present. 5

2. Preapical dorsal tibial bristles absent; costa beyond vein 1 without spaced spines; postfrons of male narrowed. ..... *Waterhouseia*

——Each tibia with 1 preapical dorsal bristle; costa beyond vein 1 with short spaced spines among the setulae; postfrons not sexually dimorphic. 3

3. Sternopleural bristles 2; marginal cell with crossveins. ..... *Xeneura**

——Sternopleural bristle 1; marginal cell without crossveins. 4

4. Dorsocentral bristles 0+3. ..... *Fenwickia**

——Dorsocentral bristles 1+3. ..... *Aneuria**

5. Vein 7 visible as a fold in membrane beyond alula; vein 6 usually extending to wing margin, though faint apically. 6

——Vein 7 absent; vein 6 not extending to margin. 11

6. Scutellum bare, except for 2 pairs of marginal bristles. 7

——Scutellum haired or setulose. 9

7. Face uniformly sclerotized across whole width on upper part, where it is deeply excavated; subcosta and vein 1 not distinctly divergent distally. ..... *Ollix*

——Face with pair of sclerotized lateral plates separated by a desclerotized or weakly sclerotized median strip; subcosta and vein 1 strongly divergent distally. 8

8. Pteropleuron setulose; 4 pairs of dorsocentral bristles present. ..... *Pseudoleria*

——Pteropleuron bare; 3 pairs of dorsocentral bristles present. ..... *Tephrochlamys**

9. One or 2 pairs of dorsocentral bristles present; all femora with thick ventral spines; face uniformly sclerotized. ..... *Tapeigaster*

——Four or more pairs of dorsocentral bristles present; femora without such spines, though often with ventral bristles; face not uniformly sclerotized. 10

10. Lateral facial plates forming a pair of deeply concave oval pits on upper part of face, not extending to near vibrissae; 4 or more upper sternopleural bristles in a horizontal series. ..... *Amphidysis*

——Lateral facial plates not forming such pits, reaching narrowly to level of vibrissae; one strong upper sternopleural bristle present. ..... *Aecothea*

11. Mid tibia with one to 3 anterior bristles and a pair of approximated preapical dorsal bristles; costa without spaced spines. ..... *Borboroides*

——Mid tibia without anterior bristles, except for the terminal to subterminal ones. 12

12. One or 2 dorsocentral bristles; preapical dorsal tibial bristle often weak or absent; costa not spinose. 13

——Three to 5 dorsocentral bristles; preapical dorsal tibial bristles present; costa sometimes spinose. 15

13. Subcosta incomplete, not nearly reaching costa; scutellum not haired; wing without markings. ..... *Heleomicra*

——Subcosta complete; scutellum haired; wing spotted. 14

14. Vertex of head not excavated; vibrissa absent; mesopleuron not haired. ..... *Zentula*

——Vertex broadly excavated; vibrissa developed as the foremost member of series of cheek bristles; mesopleuron haired. ..... *Cairnsimyia*

15. Mid tibia with one preapical dorsal bristle and no other bristles except the terminal ones; propleural bristle long and strong; dorsocentrals 1+4. ..... *Pentachaeta*

——Mid tibia with more than one bristle; propleural short and weak, often minute; dorsocentrals 3 or 4. 16

16. Some well developed acrostichal bristles present in addition to the prescutellar pair; mid tibia with one preapical dorsal bristle and one or two posterodorsal bristles on distal third; costa not spinose. ..... *Prosopantrum*

——At most only the prescutellar acrostichals present; mid tibia with two approximated preapical dorsal bristles and no posterior bristles; costa usually with short spaced spines. 17

17. Scutellum bare (except for the 2 pairs of major bristles). 18

——Scutellum haired or setulose. 20

18. Scutellum broadly rounded; arista plumose (bipectinate as in *Drosophila*). ..... *Allophylina**

——Scutellum more elongate, ovate-triangular; arista with very short hairs only. 19

19. Dorsocentrals 0+3; mesopleuron bare; wings with small markings on cross-veins only. ..... *Leriopsis*

——Dorsocentrals 1+2; mesopleuron setulose; wings with extensive blackish markings. ..... *Trixoleria*

20. Prosternum setulose; base of radial vein with one or 2 fine posterior setulae on dorsal surface near humeral crossvein; scutellum with a few fine hairs; (dorsocentral bristles 0+3). ..... *Allophylopsis**

——Prosternum bare; base of radial vein bare; scutellum with rather coarse setulae. 21

21. Dorsocentrals 0+3; mesopleuron setulose. ..... *Austroleria*

——Dorsocentrals 1+3; mesopleuron bare. ..... *Diplogeomyza*

*Genus occurs in New Zealand but is not known from Australia, and is, therefore, not treated further in this paper.

Genus *Pseudoleria* Garrett

Pseudoleria Garrett, 1921: 128. Type-species *Blepharoptera pectinata* Loew.

This genus is native to North America, but at least two species are introduced in south-temperate countries, including Australia (McAlpine, 1984).

Genus *Aecothea* Haliday

Aecothea Haliday, 1838: 137. Type-species (monotypy) *Helomyza fenestralis* Fallén.

Neoecothea Peterson & Gill, 1982: 219. Type-species *Helomyza fenestralis* Fallén. New synonym.

This genus has long been known by the name *Aecothea*, or its variant *Oecothea*, on the basis of Haliday's publication alone. This usage has been recently disputed (Thompson & Mathis, 1980; Peterson & Gill, 1982), on somewhat confused grounds. These authors appear to agree that *Oecothea* Curtis, 1837, is unavailable, as it was introduced in synonymy, but then regard Curtis's publication as the original publication for purposes of type designation for the genus *Oecothea* (or *Aecothea*) Haliday. Further, *Oecothea* Curtis was, until 1980, a *nomen oblitum*.

Proposed alterations to the International Code may partly overcome the objections to availablility of *Oecothea* Curtis, but Thompson & Mathis designate as its type-species *Leria subterranea* Robineau-Desvoidy which is currently a *nomen dubium* (B.H. Cogan *in litt.*)

It is further possibile that an objection should be raised to the use of *Neoecothea* as an alternative name to *Aecothea*. Peterson & Gill (1982) announced their new name in the title of their work thus: "*Neoecothea*, a New Name for *Oecothea* (Diptera: Heleomyzidae)". Though the following text is at variance with the view that *Neoecothea* is a new name for *Oecothea*, the title might be considered a statement in itself. Such a conflict is resolved by Art. 67(i) of the International Code, which gives the type of the new generic name as the same as that of the name it replaces, "despite any statement to the contrary". Therefore, if the designation by Thompson & Mathis (1980) of *Leria subterranea* as type of *Oecothea* be acceptable (a doubtful point), then that is also the type of *Neoecothea*, the two names being objective synonyms.

Because a final decision on the name of the genus cannot be made at present, I continue to use the name *Aecothea* Haliday in accordance with predominant usage.

Aecothea fenestralis (Fallén) is an introduced European species, found in Tasmania and the mountains of New South Wales.

Genus *Tapeigaster* Macquart

Tapeigaster Macquart, 1847: 86–87 (in reprint). Type-species *T. annulipes* Macquart.

Sciomyzoptera Hendel, 1917: 46–47. Type-species *S. annulata* Hendel.

This is a genus of 11 known species endemic in temperate Australia. There is a recent revision by McAlpine & Kent (1982). The larvae live in fructifications of fungi and have been described by McAlpine & Kent.

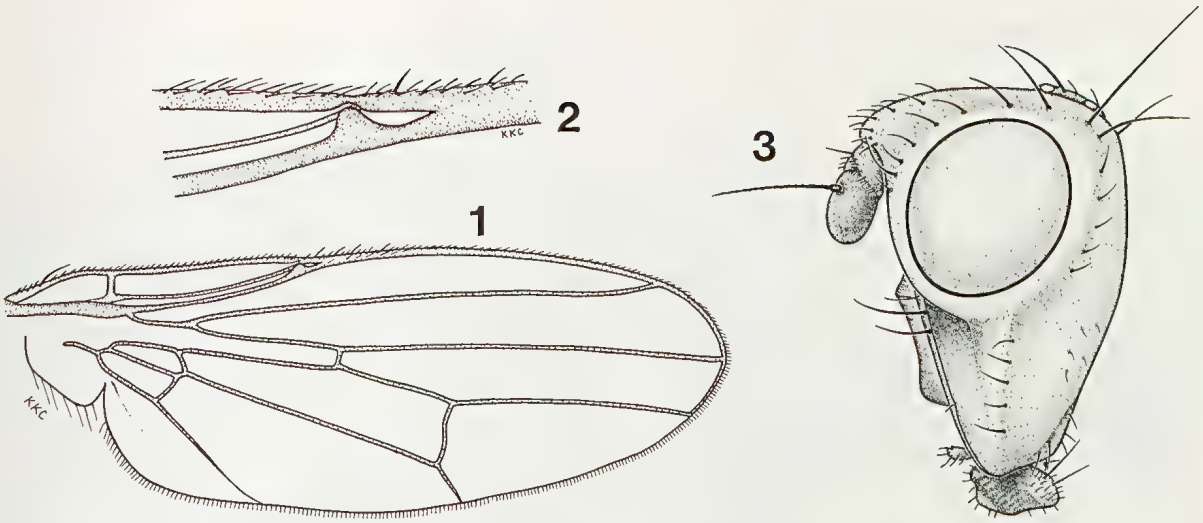
Ollix n. gen.

Type-species. *Ollix cogani* n.sp.

Description (female). Rather small flies of medium build. Male unknown.

Head obliquely triangular in profile, prolonged below; inner vertical bristles situated in front of outer verticals; postverticals convergent; 2 fairly strong upper fronto-orbital bristles directed outwards and forwards; in front of these a series of proclinate orbital setulae, sometimes intergrading with bristles, one of the foremost setulae larger than the others and incurved; central part of postfrons anteriorly with numerous proclinate setulae; face short, uniformly sclerotized, deeply excavated except for narrow lower marginal zone, with a slight linear median keel within concavity; vibrissa subtended by a strong bristle, sometimes a setula located just above vibrissa (on one side of one specimen); postgena with a vertical series of setulae; no other stong bristles on cheek region. Antenna deflexed from articulation between segments 1 and 2; segment 1 setulose above; segment 3 rounded oval, with arista inserted slightly before middle; segment 5 of arista short, strongly swollen; segment 6 minutely pubescent on its whole length, only slightly swollen basally. Prelabrum rather weakly developed, well removed from face; palpus and proboscis short.

Thorax with the following bristles: propleural, 3 sternopleurals, humeral, prescutellar acrostichal, 1+1 notopleurals, prescutellar acrostichal, 1–2+4–5 dorsocentrals, supra-alar, postalar, intra-alar; prostigmatal and mesopleural bristles absent; propleuron and mesopleuron without hairs; intradorsocentral setulae in 4 rows anteriorly, becoming irregular posteriorly; scutellum short, broad, convex,



Figs 1–3. *Ollix cogani* n.sp. **1**, wing. **2**, stigmatal region of wing. **3**, head.

without hairs; prosternum oval, very small, deeply grooved medially, pubescent. Fore femur with series of dorsal bristles; hind femur with one or 2 anterodorsal bristles distally; femora otherwise without differentiated bristles; tibiae each with one preapical dorsal bristle, shortest on fore tibia; all tarsi slender, somewhat depressed distally. Costa with few spines, not strongly differentiated from hairs, both before and beyond termination of subcosta; subcosta strongly developed throughout, immediately before its termination in the costa touching the node-like preapical expansion of vein 1; vein 2 long, diverging from vein 3 distally; anal crossvein recurved, making the posterodistal angle of anal cell obtuse; vein 6 reaching margin, curved apicad distally; vein 7 weak and almost unpigmented but visible under suitable lighting.

Abdomen pyriform, with segments behind segment 6 slender and folding telescopically; segment 6 shorter than preceding segments; segment 7 cylindrical, with separate tergite and sternite; cerci rather slender, haired.

Discussion. *Ollix*, like *Amphidysis*, appears to be monotypic and endemic to Western Australia.

The relationships of the genus are obscure. In Malloch's (1933) key to the temperate South American heleomyzid genera, *Ollix* runs imperfectly to *Epistomyia*, to which it is probably not closely related. It differs from *Epistomyia* in the bowl-like concavity of the face, the reduced prelabrum, vein 6 reaching the margin (in *Epistomyia* vein 6 does not end as close to the margin as Malloch's description would seem to indicate), the presence of vein 7, and absence of anterior bristles on the mid femur.

There is a possibility that *Ollix* is related to *Tapeigaster*, but some points of resemblance appear to be due to symplesiomorphy. *Ollix* and *Tapeigaster* are the only Australian native genera with complete vein 6 and visible vein 7, except for *Amphidysis* which differs from both in having 2 separate facial sclerites. *Ollix* differs from *Tapeigaster* in the shape of the head, the structure of the face, the outwardly inclined fronto-orbital bristles, the presence of a propleural bristle, the more numerous sternopleural and dorsocentral bristles, the absence of hairs on the scutellum, the absence of ventral spines on the femora, the presence of costal spines, the proximity of the subcosta to vein 1 distally, and the more slender and extensile terminal abdominal segments of the female.

On the other hand there is a possibility of relationship to *Amphidysis* and thus to the Diaciini in general, if that tribe be correctly constituted. The facial region of *Ollix* differs from that of *Amphidysis* in having the sclerotized part undivided, but resembles that of *Diacia*, a neotropical genus of Diaciini, quite closely in that the sclerotized part is deeply concave with a linear median carina. The well spaced costal spines, though rather weak in *Ollix*, are unlike any form of costal armature known in the Diaciini. The structure of the distal part of vein 1 in *Ollix*, with its peculiar node meeting the subcosta, is unlike that of any other heleomyzid genus available to me.

Etymology. The generic name is from the Greek ολλιξ, drinking bowl, in reference to the structure of the face, and is feminine.

Ollix cogani n.sp.

Figs 1–3

Description (female). *Coloration*: entire insect pale fulvous, with black bristles and major setulae. Wing membrane faintly tinged with yellow, without markings. Base of abdomen darkened in paratype only (perhaps discoloured).

Dimensions: total length 2.7–3.0 mm; length of thorax 1.1–1.3 mm; length of wing 3.1–3.5 mm.

Distribution. Western Australia – south-west district, north of Perth.

Holotype ♀. Dongara, 23viii–5ix1935. R.E. Turner (BM, 1935-240).

PARATYPE. Same data, 1 ♀ (AM).

Amphidysis n.gen.

Type-species. *A. hesperia* n.sp.

Description. Slightly elongate flies of medium size, with somewhat the appearance of typical north-temperate heleomyzines, but lacking spaced costal spines.

Head: postfrons forming an acute angle with face in profile; cheek broad; occiput broadly convex; ocellar and postvertical bristles long; antennal segment 2 short, but somewhat narrowed basally as in *Tapeigaster*; segment 3 rounded oval, only slightly decumbent; arista arising from near middle of dorsal surface of segment 3, long, slender, completely bare; prelabrum very narrowly developed.

Thorax with the following bristles: 2+3 dorsocentrals, humeral, presutural, 2 notopleurals, 2 anterior intra-alars, posterior intra-alar, postalar, 2 pairs of long scutellars and several long scutellar setulae, 2 long propleurals and a few setulae between them, 5 sternopleurals together with some setulae and longer ventral hairs on sternopleuron; pleura otherwise without hairs or setulae; the following bristles absent: prescutellar acrostichal, prostigmatal, mesopleural; scutellum short, subtriangular; prosternum rather narrow, with a few long hairs. Femora stout; fore femur with dorsal and posteroventral bristles; mid femur with weak anteroventral and posteroventral series of bristles, and 2 or more preapical posterior bristles, with anterior bristles weakly differentiated; hind femur with short oblique series of anterodorsal bristles; each tibia with one preapical dorsal bristle and no other strong bristles except the terminal ones. Costa with subcostal break consisting of a constriction rather than a deep incision; subcosta well separated from vein 1 distally, but only slightly diverging from it; anal cell acute distally, with anal crossvein slightly indented; vein 6 reaching margin, its apical part slightly curved basad; vein 7 rather long but, as usual, weakly sclerotized.

Abdomen (female): terminal segments elongate, folding telescopically; cerci somewhat elongate.

Etymology. The name *Amphidysis* is derived from the Greek αμφιδνσιζ, a double cup, in reference to the facial structure, and is feminine.

Discussion. *Amphidysis* differs from all other heleomyzid genera except *Dichromya* in the structure of the face as indicated in the key to tribes. It differs from *Dichromya* in the bare arista, less reduced eyes, duplication of the propleural (proepisternal) bristle, absence of the prostigmatal (proepimeral) bristle and of mesopleural setulae, much longer dorsocentral and marginal scutellar bristles, narrow prosternum, differently shaped anal cell, complete vein 6, long, curved vein 7, and long, extensile terminal segments of the female abdomen. Further, it seems improbable that the female of *Amphidysis* is viviparous, as is that of *Dichromya*, judging from the meagre material of the former.

Amphidysis is monotypic, as far as is known.

Amphidysis hesperia n.sp.

Figs 4–9,42,73

Description. *Coloration*: head orange-fulvous with pale pruinescence posteriorly; upper half of occiput and ocellar triangle grey; a black, non-pruinescent spot on each side of vertex between inner vertical and postvertical bristles. Thorax and abdominal tergites black, with ground-colour entirely concealed by dense grey pruinescence tinged with yellow in parts. Coxae and femora grey; trochanters brown; tibiae fulvous, browned apically, the hind one most strongly so; tarsi fulvous, with apical segment greyish brown. Thoracic bristle and hairs predominantly black; many of the longer ventral hairs yellowish, including those on femora. Wing membrane unpigmented. Haltere pale fulvous.

Male postabdomen: sternites 6 and 7 large, obliquely placed; segment 6 with supernumerary sclerite (X in Fig. 73) on left side; spiracles of segment 6 and at least left one of segment 7 in membrane (right spiracle 7 not found in the single preparation); surstylus very obtuse, incompletely articulated with epandrium; hypandrium with one pair of bidentate gonites, anteriorly with a small gibbosity on each side bearing 3 setulae; basiphallus short, well sclerotized; distiphallus large, elongate, with basal collar and 2 short sub-basal processes, slender for much of length beyond collar with pair of longitudinal pigmented strips, distally expanded into a partly scabrous bulb; aedeagal apodeme not examined; cerci short, rounded, separate.

Dimensions: total length, ♂ 4.9–5.4 mm, ♀ 5.1–7.1 mm; length of thorax, ♂ 1.9–2.3 mm, ♀ 2.1–3.0 mm; length of wing, ♂ 4.9–5.2 mm, ♀ 5.5–7.1 mm.

Distribution. Western Australia – south-west district from vicinity of Perth southwards.

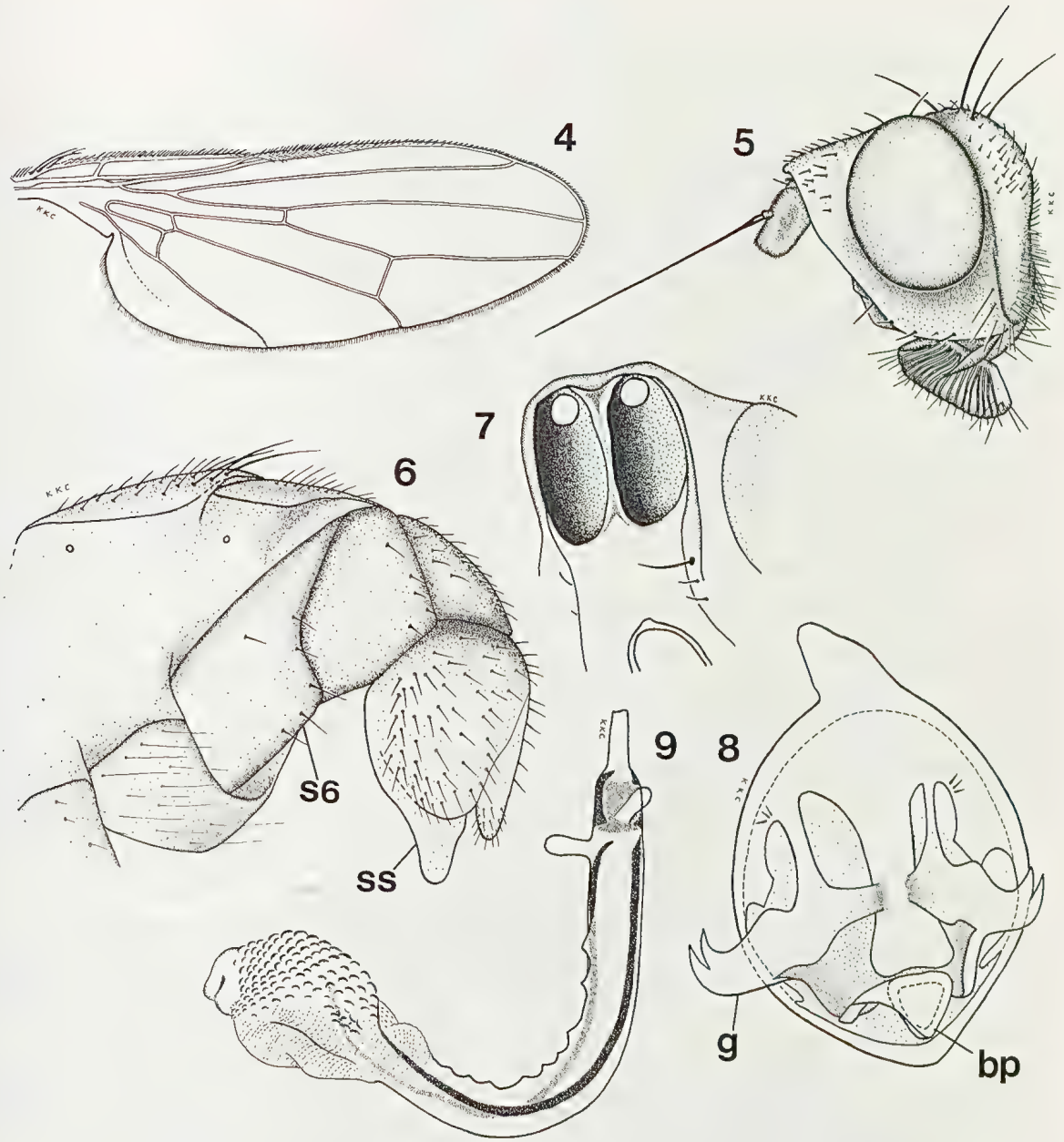
HOLOTYPE ♂. Nedlands, near Perth, light trap, 17vi1959, M.M.H. Wallace (ANIC).

PARATYPES. Quilergup, E of Busselton, vii,viii1976, S.J. Curry, 1 ♂, 2 ♀ (AM, ANIC).

Genus *Prosopantrum* Enderlein

Prosopantrum Enderlein, 1912: 135. Type-species *P. austrinum* Enderlein (= *Agromyza diademata* Bigot).
Acrostichalia Tonnoir & Malloch, 1927:86. Type-species *A. flavifrons* Tonnoir & Malloch.
Cnemospathis Enderlein, 1938: 655. Type-species *C. baeckstroemi* Enderlein (= *A. flavifrons* Tonnoir & Malloch).

This genus is indigenous to temperate South America, 12 species being listed by Gill (1968). One of these species, *P. flavifrons* (Tonnoir & Malloch, 1927), is widespread in temperate parts of the southern hemisphere, presumably through human activities. It appears that all specimens collected outside the native



Figs 4–9. *Amphidysis hesperia* n.sp. **4**, wing (alula not visible). **5**, head. **6**, male postabdomen (oblique left lateral aspect, with asymmetrically placed genital segment in direct lateral aspect). **7**, facial region (antennae omitted). **8**, hypandrium (distiphallus removed). **9**, distiphallus (to half scale of Fig. 8). **bp**, basiphallus. **g**, gonite. **ss**, surstylus. **s6**, sternite 6.

haunts of this species are females, and, as noted by Cogan (1971), these introduced populations may be entirely parthenogenetic.

The only Australian specimens of *P. flavifrons* that I have seen are from Tasmania (AM, ANIC).

Cogan (1971) records that label data indicate an association with faecal matter and carrion.

Genus *Leriopsis* McAlpine

Leriopsis McAlpine, 1967: 76. Type-species *L. montana* McAlpine.

This is an apparently monotypic genus, inhabiting highlands of Tasmania and Victoria, and the Snowy Mountains of New South Wales. It is common at higher altitudes in Tasmania in summer, particularly in forests of deciduous beech (*Nothofagus gunnii*), but has been seldom collected in other states.

Genus *Trixoleria* McAlpine

Austroleria McAlpine, 1967: 80. Type-species *A. extensa* McAlpine.

This apparently monotypic genus is widely distributed in southern Australia. *Trixoleria maculata* is here recorded from Western Australia for the first time

(Crowea State Forest, ANIC).

Genus *Austroleria* McAlpine

Austroleria McAlpine, 1967: 80. Type-species *A. extensa* McAlpine.

Austroleria includes 2 known species, widely distributed in southern Australia but possibly absent from Western Australia. The presence of *A. extensa* on Kangaroo Island, South Australia (AM), extends the recorded distribution of the genus to that state.

Genus *Diplogeomyza* Hendel

Diplogeomyza Hendel, 1917: 38. Type-species *D. diaphora* Hendel.

A genus of about 18 species, 15 already described, found in temperate Australia and extending into tropical Queensland on the highlands. I have previously revised the genus (McAlpine 1967).

Genus *Borboroides* Malloch

Borboroides Malloch 1925: 85. Type-species *B. atra* Malloch.

This genus was originally placed in the Borboridae (Sphaeroceridae), but has not the diagnostic characters which separate that family from the Heleomyzidae, and the larger species lack the superficial resemblance to sphaerocerids present in the minute type-species.

I interpret the genus broadly to include about 9 species in available collections. These show such a range of variation that I formerly inclined to place the species in 3 genera. In view of the intermediate characters of some species, I now recognize one polytypic genus. More material will be required, particularly from Victoria and Tasmania, to make a satisfactory revision possible.

Borboroides atra, the only species of the genus yet described, is smaller than most species, and has dorsocentral bristles reduced to one or 2 pairs (commonly 3 pairs in other species), the discal cell compact and bounded posteriorly by a strongly curved section of vein 5, the fronto-orbital bristles in two subequal pairs strongly flexed outwards, the mesopleuron setulose, and the protandrium symmetrical (Fig. 81) (asymmetrical in other species examined: Fig. 80). The species lies near the extreme of a range of variation rather than in an isolated position within the genus.

With the exception of the widespread *B. atra* (southern Queensland to Tasmania and possibly south-western Australia), the species of *Borboroides* are found mainly in cool, mountain *Eucalyptus* forest (but not temperate rainforest as is favoured by *Diplogeomyza* species), and adults are found mainly in spring and autumn.

Heleomicra n.gen.

Type-species. *Heleomicra collessi* sp. nov.

Description. Minute blackish flies superficially resembling the smaller species of *Borboroides* (e.g. *B. atra* Malloch), having the general characters given below for the tribe Borboroidini.

Head: higher than long; postfrons with few minute hairs only; the 2 fronto-orbitals strong, subequal, directed outwards, posterior one sloped backwards, anterior one sloped forwards; face sclerotized, slightly concave, with rounded transverse ridge along lower margin; cheek with 2 series of bristles or setulae behind vibrissa. Antenna somewhat decumbent; segment 1 vestigial; segment 2 rather short and not overlapping segment 3 dorsally.

Thorax: mesopleuron without setulae; one sternopleural present; humeral and presutural bristles weak but distinct; one dorsocentral situated in front of line of postalar bristles; acrostichals absent; intra-alar bristle reduced; mesoscutum with rather numerous setulae centrally, some of which are longitudinally aligned with dorsocentral bristles. Fore femur with long posterodorsal and shorter posteroventral bristles; mid femur with an anterior bristle near middle and a smaller one near apex; hind femur without strong bristles; tibiae without bristles, except for one anterior and one ventral terminal spur on mid tibia. Costa not visibly weakened just beyond humeral crossvein, with inconspicuous subcostal break; without spines among the hairs; subcosta distally obsolete, not merging with vein 1, though the distal dilation of the latter may give the impression of a double vein from some angles; veins 2 and 3 subparallel distally, forking distinctly before level of discal cell; anal cell obtusely angular posterodistally, wider than first basal cell at level of fork of veins 2 and 3; vein 6 short, not much curved.

Male postabdomen (Fig. 82): tergite 6 reduced in size but sclerotized; sternites 6 and 7 much reduced, located on left side and connected to the large dorsal sternite 8; left spiracle 7 situated within compound sternite (spiracles of right side not seen); genital segment short and broad, not constricted anteriorly as in *Borboroides*; surstylus basally articulated; aedeagus with large, elongate, scoop-like basiphallus; distiphallus with complex sclerotization, folding into groove on anterior face of basiphallus; cerci separate.

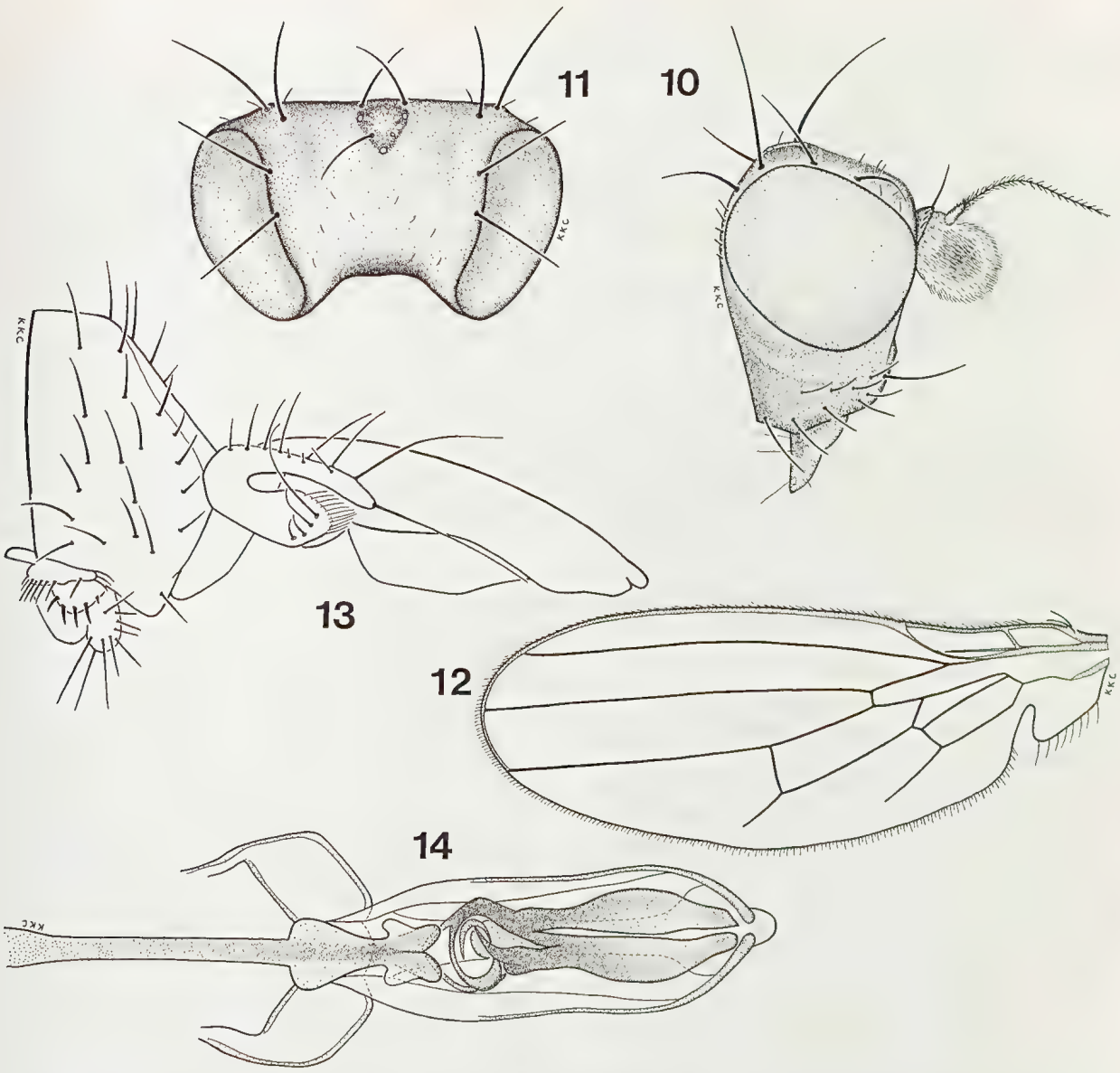
Female postabdomen folding telescopically, with segments behind segment 5 progressively reduced in size; segment 7 with separate tergite and sternite; cerci elongate, separate.

Discussion. This is a genus of at least 2 species. They are known from New South Wales, Victoria, Tasmania, and South Australia, but have been seldom collected. One specimen was collected together with numerous specimens of the superficially similar *Borboroides atra* on a skinned, drying kangaroo carcase in dry sclerophyll forest.

Heleomicra collessi n.sp.

Figs 10–14

Description. *Coloration*: head brown-black; anterior part of postfrons broadly orange-tawny; face,



Figs 10–14. *Heleomicra collessi* n.sp. **10**, head. **11**, frontal region of head. **12**, wing. **13**, genital segment (left lateral aspect, aedeagus extended posteriorly). **14**, aedeagus (ventral aspect).

cheek, and palpus fulvous; antenna fulvous, with segment 3 partly suffused with brown. Thorax dark brown. Legs brown, with coxae and bases of femora fulvous. Wing membrane indistinctly uniformly smoky. Haltere pale yellowish. Abdomen black.

Wing: distal section of vein 6 about three quarters as long as anal cell in male, slightly longer in female, sclerotized and pigmented for more than halfway from anal crossvein to margin, then abruptly discontinued.

Male postabdomen: surstylus complex, setulose; cercus large, very deeply bifid, the lower lobe broader and a little shorter than upper one.

Other characters as given for genus.

Dimensions: total length, ♂ 1.3–1.4mm, ♀ 1.8mm.; length of thorax, ♂ 0.53–0.58 mm, ♀ 0.74 mm; length of wing, ♂ 1.6–1.8 mm., ♀ 2.1 mm.

Distribution. New South Wales – Western Slopes district.

HOLOTYPE ♂: Goonoo State forest, 8 km south of Mendooran, 1–3 v 1970 (AM), G.A.Holloway and D.K.M.

PARATYPES: Wombat, near Young, vi 1966 (1 ♂ ANIC), Z.R. Liepa; Camp Wambelong, Warrumbungle National Park, near Coonabarabran, vi 1982 (1 ♀ AM), K.C.Khoo.

Discussion. More material is needed to decide the number of species in *Heleomicra* and their distinguishing characters. There is at least one other species from Victoria and Tasmania which appears to be distinguishable from *H. collessi* in having the distal section of vein 6 more reduced and the male cerci undivided.

Genus *Cairnsimyia* Malloch

Cairnsimyia Malloch, 1931: 294. Type-species *C.cavifrons* Malloch.

In my revision (McAlpine, 1968) I recorded 9 species, 6 from Australia and 3 from New Guinea. Since then, one of the New Guinea species, *C. aroana* McAlpine, has been collected in Australia (Claudie River, North Queensland, AM) and 3 undescribed Australian species have been collected (AM, ANIC).

Cairnsimyia is the only heleomyzid genus recorded for New Guinea where it occurs on the highlands and near sea level.

Zentula n.gen.

Type-species. *Z.vittata* n.sp.

Description. Rather robust flies resembling the smaller species of *Cairnsimyia* in appearance, and having the general characters of the tribe Rhinotorini given below. Cuticle pruinescent and scarcely shining.

Head not distinctly excavated at vertex; check broad; hypofacial not, or very narrowly, developed below cheek; fronto-orbital bristles 2, short, reclinate; convergent postvertical bristles present; cheek bristles and vibrissa absent; antenna as in *Cairnsimyia*; prelabrum small; palpus prominent, elongate, cylindrical-clavate, not compressed; labella of proboscis vestigial.

Thorax pale, with extensive brown markings; mesoscutum and dorsal surface of scutellum setulose; mesopleuron bare; the following bristles present: humeral, notopleurals, supra-alar, postalar, posteria intra-alar, prescutellar acrostichal, 2 closely placed posterior dorsocentrals, 2 pairs of scutellars, one or 2 propleurals, usually 4 sternopleurals progressively longer posteriorly, presutural bristle absent or vestigial. Fore femur with irregular dorsal bristles and variably developed posteroventral comb distally; other femora with bristles absent or little developed. Wing resembling that of *Cairnsimyia*, with numerous brownish spots; veins 2 and 3 slightly divergent apically; veins 2 and 4 slightly convergent apically; discal crossvein transverse or almost so.

Abdomen resembling that of *Cairnsimyia*.

Discussion. *Zentula* is closely related to *Cairnsimyia*, but the latter has the vertex excavated; the hypofacial well developed below the cheek; the vibrissa developed as the foremost, and usually strongest, member of a series of check bristles; the prelabrum large and prominent; the palpus shorter, not clavate, and usually more or less compressed; the mesopleuron haired; only one pair of dorsocentral bristles; and the discal crossvein generally more oblique.

In addition to the type-species here described, a second species of *Zentula* occurs in the Cooktown district of North Queensland (ANIC).

Etymology. The generic name commemorates the collector, Miss Zenta R. Liepa, of C.S.I.R.O. Division of Entomology, Canberra.

Zentula vittata n.sp.

Figs 15–17

Description (female). *Coloration*: head pale buff; postfrons with large fulvous orange zone occupying anterior part and extending on each side of blackish ocellar zone posteriorly; antenna and palpus fulvous. Thorax pale buff; mesoscutum with lateral brown stripe anteriorly on lower part of humeral callus and notopleuron, a sublateral brown stripe from just above humeral callus to postalar callus, and a pair of complete submedian brown stripes which are joined for a short distance just in front of suture; scutellum with pair of brown zones dorsally; pleura with horizontal brown stripe on upper margins of propleuron and mesopleuron, a brown mark below middle of propleuron, a brown stripe across middle of mesopleuron and pteropleuron; sternopleuron suffused with brown. Femora brown with variable irregular yellowish suffusions; fore and mid tibiae yellowish with basal, premedial, and apical brown bands; hind tibia yellowish with basal and sub-basal brown bands; tarsi yellowish. Wing with extensive pattern of mostly simple brown spots as in Fig 17; haltere pale yellowish, with slight brownish suffusion on capitellum. Abdomen tawny, paler distally, with brown suffusion on parts of segments 1–3.

Head in dorsal view with frontal lunule narrowly visible in front of ptilinal suture; posterior fronto-orbital bristle larger than anterior one.

Thorax: mesoscutum without supernumerary bristles just in front of scutellar suture; propleuron with one fairly strong and one much weaker bristle.

Dimensions: total length 3.1–3.5 mm; length of thorax 1.7–1.9 mm; length of wing 3.4–3.6 mm.

Distribution. Southern New South Wales; Australian Capital Territory.

HOLOTYPE ♀. Black Mountain Reserve, Canberra, A.C.T., 16 x 1977 (ANIC), Z.R. Liepa.

PARATYPE. Congo, 8 km ESE of Moruya, N.S.W., iv 1981 (1 ♀, AM), M.S. Upton.

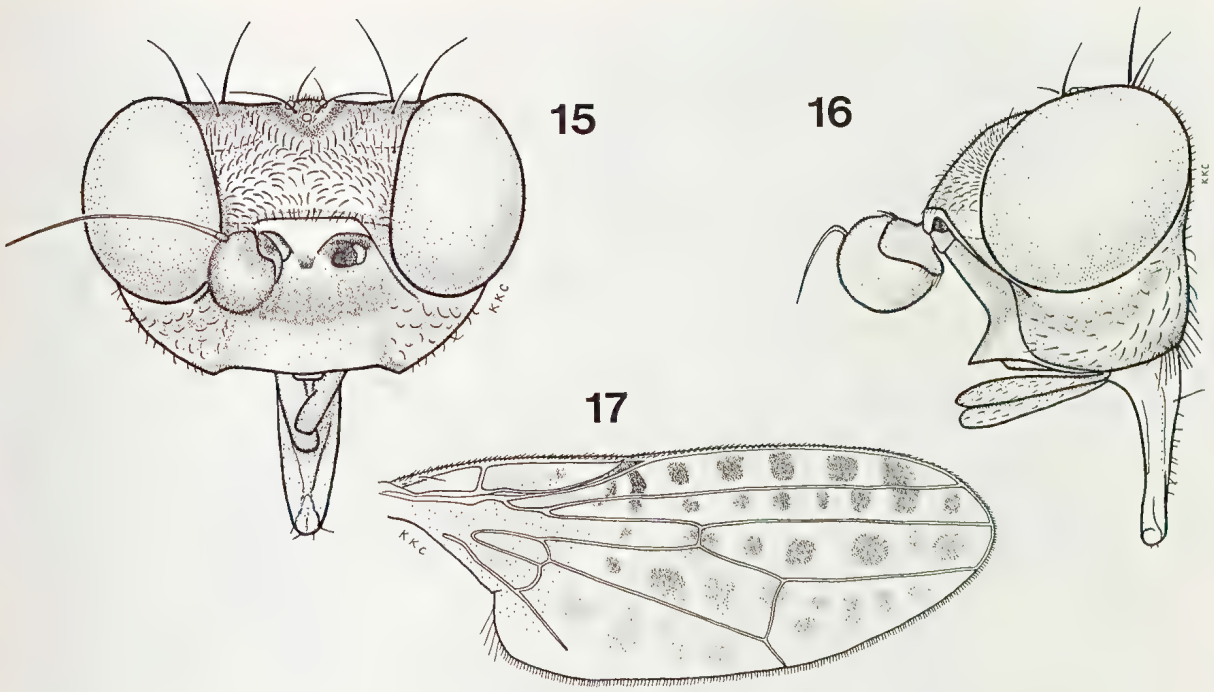
Pentachaeta n.gen.

Type-species. *P. physopus* n.sp.

Description. Rather robust flies of moderately small size, having the characters given for the tribe Pentachaetini.

Coloration: general coloration generic; head and thorax fulvous-orange, finely, densely pruinescent; humeral callus and a stripe covering suture between notopleuron and mesopleuron dark brown; legs fulvous, variously marked with brown; wing clear, with broad dark brown band along entire costal margin, becoming broader and more diffuse apically, terminating just behind vein 4, and with separate brown spot on discal crossvein, none on anterior crossvein; abdomen light brown.

Head: postfrons with several anterior marginal bristles overhanging ptilinal suture; cheek with a series



Figs 15–17. *Zentula vittata* n.sp. **15, 16,** head. **17,** wing.

of strong setulae on lower margin; lower occiput with pair of bristles directed towards fore coxae.

Thorax: propleural bristle long; upper part of sternopleuron with one long bristle and a series of hairs; anterior notopleural bristle longer than posterior one; dorsocentral bristles 5, subequal; scutellum without hairs. Tibiae of males variously swollen in certain species, those of females not so modified. Second basal and anal cells moderately short, their lengths more than 0.2 that of discal cell.

Male postabdomen (Fig. 93) with tergite 6 sclerotized, free, not setulose; sternite 6 reduced, displaced to left side and joined to sternite 8 to form a synsternite; sternite 7 doubtfully identifiable as part of this synsternite; epandrium with one pair of articulated surstyli; hypandrium with 2 pairs of posterior gonites, sometimes small; aedeagus not very elongate with complex distal sclerotization, without distinctly sclerotized basiphallus; aedeagal apodeme large, with elbow-like joint, the anterior part bent downwards from the articulation and, from a little behind its anterior end, with a process which passes posteriorly and is joined to hypandrium; ejaculatory sclerite rather small; cerci variable, often large.

Female postabdomen with no elongate segments; segment 7 with tergite and sternite fused into a ring enclosing seventh pair of spiracles; cerci short, well separated.

Discussion. *Pentachaeta* is a genus of at least 7 species (all but the type-species remaining undescribed) distributed from the Atherton Tableland, in tropical Queenland, to Tasmania and South Australia. The greatest concentration of species is in eastern New South Wales, where at least 5 species occur. They live in wetter forests and are frequently taken in traps baited with mammalian faeces, particularly in summer.

The species are very uniform in appearance and chaetotaxy and may be distinguished from other Australian heleomyzids by the presence of 5 pairs of dorsocentral bristles in combination with the characteristic wing markings (Fig. 18). The differences between species consist mainly of details of coloration of the antenna, palpus, sternopleuron and legs, of the extent of thickening of the male tibiae, and of the structure of the male genitalia.

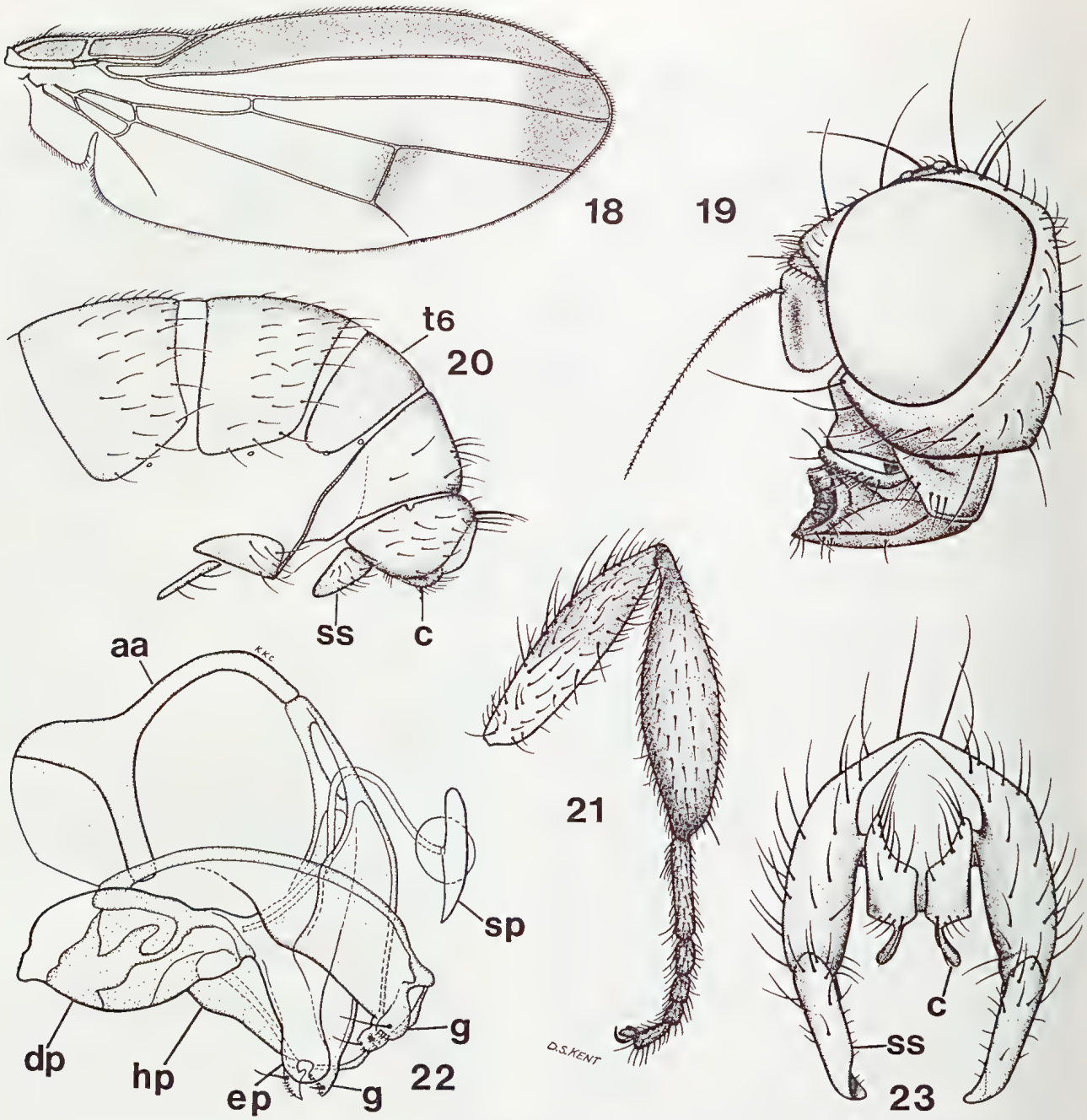
Pentachaeta physopus n.sp.

Figs 18–23

Description. *Coloration*: antenna entirely orange-fulvous, except for the brownish arista; palpus pale fulvous. Sternopleuron without dark mark. Coxae and trochanters fulvous; fore femur dark brown with well defined fulvous basal zone; fore tibia and tarsus entirely dark brown; mid leg entirely fulvous; hind leg fulvous with apex of femur often narrowly browned, in male much of tibia and base of tarsus often also browned.

Legs: all tibiae of male strongly, but somewhat variably, swollen, the fore and hind ones sometimes thicker than femora; tibiae of female relatively slender.

Male postabdomen: epandrium short, reduced to a narrow arch dorsally, with 2 pairs of dorsal bristles, the anterior pair longer; surstylus narrowly ovate, with several strong black setulae; each lateral hypandrial ridge with 2 small gonites at its posterior end, each gonite with one long setula and several minute ones; distiphallus stoutly clubbed, with complex, symmetrical sclerotization; a large transparent epiphallus (spinus) arising from posterior surface of aedeagus; cerci large,



Figs 18–23. *Pentachaeta physopus* n.sp. **18**, wing. **19**, head. **20**, male postabdomen from segment 4. **21**, fore leg of male (femur to tarsus only). **22**, hypandrium with aedeagus (left lateroventral aspect). **23**, epandrium (posterior aspect). **aa**, aedeagal apodeme. **c**, cercus. **dp**, distiphallus. **ep**, epiphallus. **g**, gonites. **hp**, hypandrial plate. **sp**, sperm pump. **ss**, surstylus. **t6**, tergite 6.

complex, separately sclertoized, each with broad setulose dorsal plate and slender ventral process.

Dimensions: total length, ♂ 2.5–3.0 mm, ♀ 2.2–3.5 mm; length of thorax, ♂ 1.2–1.4 mm, ♀ 1.2–1.6 mm; length of wing, ♂ 3.0–3.5 mm, ♀ 3.0–3.8 mm.

Distribution. New South Wales – coast districts and adjacent ranges.

HOLOTYPE ♂. Mooney Mooney Creek, near Gosford, 20 xi 1975 (AM), D.K.M.

PARATYPES. Mooney Mooney Creek, i xi xii 1975–1978 (15 ♂, 16 ♀, AM, ANIC, BM), B.J. Day and D.K.M.; Upper Allyn, near Eccleston, xi 1965 (l ♂, l ♀, AM), D.K.M.; Bowen's Creek, Blue Mountains, xii 1956 (l ♂, AM), D.K.M.; Wentworth Falls, Blue Mountains, ii xi xii 1957–1958 (12 ♂, 8 ♀, AM, CNC, USNM), D.K.M.; Springwood, i 1956 (l ♀, AM), D.K.M.; (Royal) National Park, i ii iii x xi xii 1955–1978 (10 ♂, 3 ♀, AM, MNM), G. Daniels, D.K.M.; Otford, Illawarra District, i ii 1964 (l ♂, l ♀, AM), D.K.M.

Discussion. *Pentachaeta physopus* is distinguished from other, undescribed species of the genus by the

entirely dark brown fore tibia and tarsus in combination with the entirely pale colouring of the antenna, palpus, and sternopleuron. The shape of the surstylus and other details of the male genitalia are distinctive. The swollen tibiae of all legs in the male, particularly the fore and hind ones, serve to distinguish this from some of the species.

Genus *Waterhouseia* Malloch.

Waterhouseia Malloch, 1936: 260–261. Type-species *W. cyclops* Malloch.

The only known species lives in the Central and Southern Tableland districts of New South Wales. It is uncommon, but small numbers of adults have been obtained by sweeping xeromorphic shrubs in dry sclerophyll forest near the tops of sandstone ridges, principally in autumn. Morphological features are given below under the tribe Waterhouseiini.

List of Australian Species.

Pseudoleria placata (Hutton, 1901) (*Leria*)
(= *Pseudoleria crassata* Garrett, 1925)
Pseudoleria pectinata (Loew, 1872) (*Blepharoptera*)
(= *Pseudoleria pectinerata* Garrett, 1921)
Aecothea fenestralis (Fallén, 1820) (*Helomyza*)
Tapeigaster nigricornis (Macquart, 1851) (*Sciomyza*)
(= *Tapeigaster marginifrons* Bezzi, 1923)
Tapeigaster cinctipes (Walker, 1853) (*Heteromyza*)
(= *Tapeigaster bella* Paramonov, 1955)
Tapeigaster argyrospila Bezzi, 1923
Tapeigaster brunneifrons Malloch, 1927
(= *Tapeigaster vernalis* Paramonov, 1955)
Tapeigaster luteipennis Bezzi, 1923
(= *Tapeigaster taylori* Malloch, 1935)
Tapeigaster annulipes Macquart, 1847
(= *Dryomyza cingulipes* Walker, 1858)
Tapeigaster paramonovi McAlpine & Kent, 1982
Tapeigaster digitata McAlpine & Kent, 1982
Tapeigaster annulata (Hendel, 1917) (*Sciomyzoptera*)
(= *Tapeigaster fulva* Malloch, 1926b)
Tapeigaster pulverea McAlpine & Kent, 1982
Tapeigaster subglabra McAlpine & Kent, 1982
Ollix cogani n.sp.
Amphidysis hesperia n.sp.
Prosopantrum flavifrons (Tonnoir & Malloch, 1927) (*Acrostichalia*)
(= *Cnemospathis baeckstroemi* Enderlein, 1938, = *Cnemospathis schoenemanni* Enderlein, 1938)
Leriopsis montana McAlpine, 1967
Trixoleria maculata McAlpine, 1967
Austroleria extensa McAlpine, 1967
Austroleria truncata McAlpine, 1967
Diplogeomyza incisa McAlpine, 1967
Diplogeomyza wirthi McAlpine, 1967
Diplogeomyza conformis McAlpine, 1967
Diplogeomyza immaculata McAlpine, 1967
Diplogeomyza hardyi McAlpine, 1967
D. hardyi hardyi McAlpine, 1967
D. hardyi tasmanica McAlpine, 1967
Diplogeomyza flavipalpis McAlpine, 1967
Diplogeomyza diaphora Hendel, 1917
Diplogeomyza tridens McAlpine, 1967
Diplogeomyza victoriae McAlpine, 1967
Diplogeomyza annularis McAlpine, 1967
Diplogeomyza spinosa McAlpine, 1967
Diplogeomyza signata McAlpine, 1967
Diplogeomyza media McAlpine, 1967
Diplogeomyza maculipennis (Malloch, 1926b) (*Huttonina*)
Diplogeomyza pectinervis McAlpine, 1967
Borboroides atra Malloch, 1925
Heleomicra collessi n.sp.
Cairnsimyia robusta (Walker, 1853) (*Heteromyza*)
Cairnsimyia excavata McAlpine, 1968
Cairnsimyia sydneiensis McAlpine, 1968
Cairnsimyia verticalis McAlpine, 1968
Cairnsimyia uniseta McAlpine, 1968
Cairnsimyia cavifrons Malloch, 1931
Cairnsimyia aroana McAlpine, 1968
Zentula vittata n.sp.
Pentachaeta physopus n.sp.
Waterhouseia cyclops Malloch, 1936

Australian Species Erroneously Referred to Heleomyzid Genera.

Helomyza marginalis Walker, 1858. The given type-locality is New South Wales. The description of *Helomyza robusta* Walker, 1858, which immediately precedes that of *H. marginalis*, refers to an insect from 'Valley of the Amazon.' In the BM collection there are two much damaged specimens on the one pin, both headless, with an apparent original Walker label '*robusta*', which should indicate type-material. The pin has also an unclear label in doubtful language mentioning '*Helomyza marginalis* Walk.' I found no other possible type-material of either nominal species. These specimens belong to the Australian lauxaniid species *Meiosimyza lineata* (Walker, 1853) (*Sciomyza*) n.comb. (= *Sapromyza bicoloripes* Malloch, 1926a, n.syn., on the basis of examination of types in BM and SPHTM respectively). They therefore disagree with Walker's locality data for *H. robusta* and appear also to agree better with the description given for *H. marginalis*. It is possible, therefore, that they are types of *H. marginalis* instead of *H. robusta*. *Helomyza marginalis* is perhaps best dismissed as a *nomen dubium*, but there is no evidence that it refers to a species of Heleomyzidae.

Helomyza pallida Walker, 1853. This was described from 'Van Diemen's Land' (now Tasmania). From examination of type-material (BM), I find it to be a lauxaniid and a synonym of *Sapromyza rufifrons* (Walker, 1853) (see below). It is a primary junior homonym of *Helomyza pallida* Fallén, 1820, a palearctic species now referred to the heleomyzid genus *Suillia* (see Czerny, 1924).

Helomyza rufifrons Walker, 1853. Examination of the type shows this to be the same as *H. pallida* Walker,

which has the same type-locality. *Sapromyza rufifrons* (Walker) is a new combination, as the species is referable to the lauxaniid genus *Sapromyza* Fallén in the broad sense in which this genus has been used in the southern hemisphere. *Sapromyza griseadorsalis* Malloch, 1926a is very closely related, perhaps even conspecific.

Helomyza vittata Macquart, 1851. I saw the type-material of this species in PM some years ago, and noted that it appeared close to the genus *Helcomyza* (family Helcomyzidae). The stated type-locality is Tasmania, but no such fly is known to have been collected in Tasmania or elsewhere in Australia in recent times.

Classification

Very diverse views have been expressed on classification of the flies I group in the family Heleomyzidae (e.g. Czerny, 1927a; Hennig, 1958, 1973; Griffiths, 1972). My concept of the Heleomyzidae is somewhat similar to that of Czerny (1927a), Malloch (1933), Harrison (1959) and Cogan (1971), though I have had to consider numerous genera not mentioned in these works, each of which is restricted to the fauna of one geographic area.

Hennig (1973) lists numerous genera under the three families Heleomyzidae, Rhinotoridae, and Trixoscelididae, but a glance at the included genera shows that this arrangement cannot be maintained. For example, the genera *Cephodapedon*, *Gephyromyza*, and *Paraneossos*, which he distributes among the families Heleomyzidae and Trixoscelididae, are, in fact, very closely related to one another. *Anastomyza* and *Apophoneura*, placed in the Heleomyzidae by Hennig, are phylogenetically close to the genera he places in the Rhinotoridae (D. McAlpine, 1968; Griffiths, 1972). *Listriomastax* and *Apetaenus*, placed in Heleomyzidae, have been removed to the Tethinidae by Griffiths (1972). *Chiropteromyza* and *Ornitholeria*, placed in the Heleomyzidae, are synonyms of *Neossos*, which is placed in the Trixoscelididae. The series of genera which Hennig places in the subfamily Heleomyzinae of the Heleomyzidae includes many groups just as distant from *Heleomyza* and its allies as are the genera placed in Rhinotoridae and Trixoscelididae.

I conclude that Hennig's grouping of genera was simply intended to show that given in recent literature, and not intended as a critical appraisal.

It is usual in taxonomic works reviewing a major group either to give a short description of the group which is intended to apply, more or less in toto, to all its members, or, following Hennig (1958), to list the apomorphic characters of the groundplan of the group. Either method gives considerable difficulty for the Heleomyzidae. Harrison (1959) was able to give a description of the family which is useful for identification of the New Zealand species, but, on a world basis, there are some departures from at least 50% of the given characters, including most of those often reckoned as most distinctive for the family. Hennig (1958) attempted to give some characters of the groundplan of the Heleomyzidae. He was not, however, familiar with the family on more than a regional basis and admitted great uncertainty as to the family limits.

It is still not possible to demonstrate by standard cladistic method the monophyly of the Heleomyzidae. Reasons for this difficulty include (1) an apparent very early (early Tertiary) radiation into a variety of niches; (2) the present impossibility of determining the sister-group of the Heleomyzidae (if one exists) and thus the difficulty of making out-group comparisons; (3) inherent difficulties in the cladistic method, e.g. the problem of reversibility of character states and possible convergent evolution of some characters in possibly related out-groups (homoplasy).

Despite these problems, there remains, in my view, a probability that the forms I place in the Heleomyzidae (or most of them) are more closely related to one another than to other Diptera. In general these forms depart only to a limited extent from a suite of basic or typical characters of the family (not necessarily groundplan characters), which I set out below. Perhaps *Mayomyia* is the genus that departs most from these characters, while *Notomyza* and *Waterhouseia* have unusual protandrial characters without being otherwise very different from certain more typical genera. There is a lack of admissible evidence that any of the less typical genera are more closely related to forms excluded from the family than to those I include, and I do not think that separating off some genera into a number of very small families would add any scientific significance to the classification.

The Chyromyidae and Sphaeroceridae are excluded from the Heleomyzidae, not because I am convinced that they are phylogenetically separate, but because their relationships are not yet understood, and diverse views of their taxonomic positions have been expressed. The large amount of literature on the Sphaeroceridae makes it undesirable to change the status of the group until stability can be assured.

I have previously initiated a system of tribes within the Heleomyzidae (McAlpine, 1967, 1968; McAlpine & Kent, 1982), a system which I here extend to cover more genera. These tribes are narrowly defined groups of genera which are probably all monophyletic groups. Some of these are necessarily restricted to a single genus (e.g. Borboropsini, Notomyzini) at the present stage of understanding of relationships.

The grouping of these tribes into larger groups (subfamilies) is a difficult problem which I have had under consideration for a long time, but, at present, I am unable to offer a satisfactory solution. Occasionally, evidence is available which suggests close relationship between certain tribes (e.g. in the structure of the pleurotergite in Allophylopsini and Cnemospathini), but in general it has not been possible to find combinations of clearly apomorphic characters which can be relied upon for grouping the tribes into higher monophyletic taxa. Like Gill (1962), I do not accept a close relationship between the Heleomyzini and Suilliini; the few resemblances are due mainly to symplesiomorphy.

It is customary with some authors to use input from geographic distribution in setting up classifications, and indeed it is often difficult to ignore data of this kind. On the other hand, it often happens that classifications, whose basis includes biogeographic evidence, are subsequently used in analyses of faunal relationships. The result is, of course, circular reasoning. I have therefore attempted to minimize geographic input in this classification; otherwise I may have been tempted to lay more stress on those morphological characters which could be used to divide the neotropical from the Australian forms in such tribes as Diaciini, Rhinotorini, and Pentachaetini.

List of Characters Typical of Heleomyzidae

Head. Sclerotized part of face not extending on to ventral surface of head capsule, but in some forms extending laterally below cheeks as the hypofacials; postvertical bristles convergent or rarely absent; fronto-orbital bristles 1 to 3, variably directed but not strongly incurved; interfrontal bristles, when present, not in longitudinal series set on a pair of differentiated plates; vibrissa usually distinct. Antenna with segment 2 not dorsally slit, nor forming a hood- or cup-like structure over base of segment 3; segment 3 without basal process fitting into segment 2.

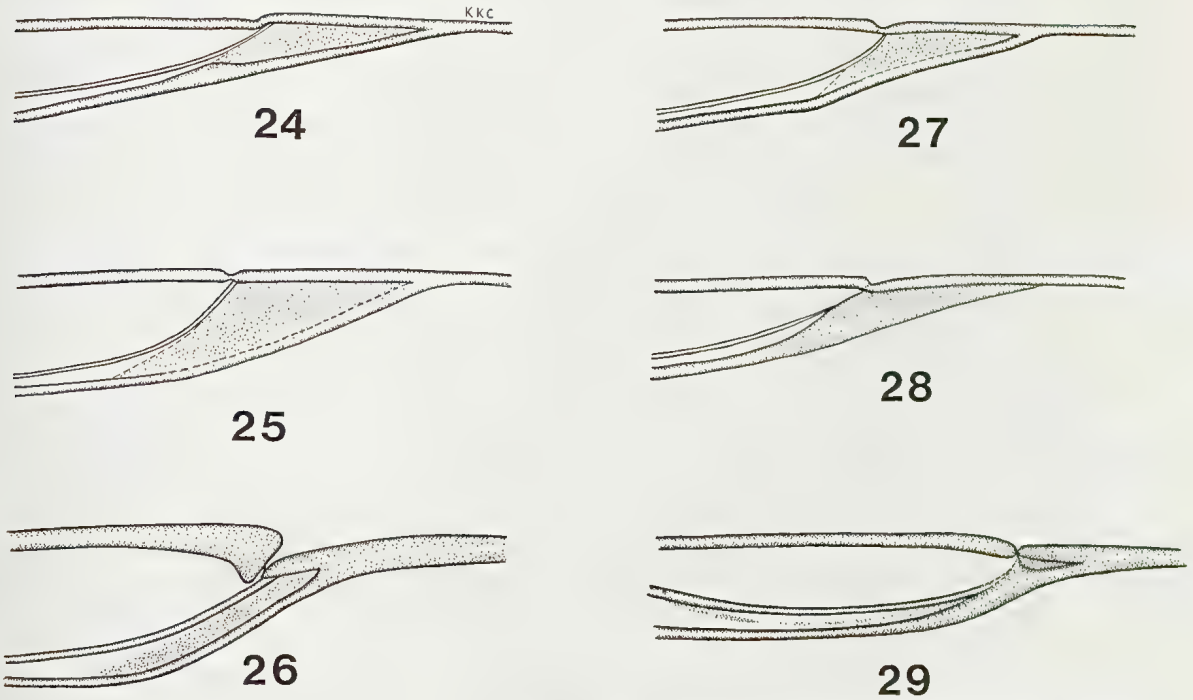
Thorax. Dorsocentral bristles usually 3 or more; presutural bristle usually present; scutellum usually with 2 pairs of subequal marginal bristles; 1 or more sternopleural bristle present; prosternum usually without well sclerotized precoxal bridges. Mid femur often with anterior bristles, which may be uniseriate; fore femur usually with posteroventral bristles, often with dorsal bristles; tibiae usually with preapical dorsal bristles, often solitary, particularly on fore tibia; hind basitarsus not exceptionally short and compact, but mid basitarsus often more elongate than other basitarsi.

Wing usually not remarkably narrowed basally; costa often with spaced spines on anterior or anteroventral surface, with a break or visible weak point at end of subcosta; vein 1 without series of dorsal setulae, on distal part often merging into a pterostigma-like thickened area of the subcostal cell (Figs 24–29); second basal cell closed; anal cell closed; section of vein 6 beyond anal cell well developed and aligned with section bordering that cell (contrast Drosophilidae); alula well developed.

Abdomen. Protandrium usually asymmetrical, with sternites 6 and 7 usually lateral, sometimes reduced; sternite 8 dorsal, usually well developed. Cerci of female usually separate.

Some Structures of Taxonomic Importance

Face. The face, mesofacial or prefrons of the Heleomyzidae is most frequently a uniformly sclerotized area between the antennal bases and the ventral membranous subcranial region. There is generally an abrupt discontinuity of the sclerotization at the lower margin. The face varies from concave in *Diacia* and *Ollix* to somewhat convex in *Cinderella* and most species of *Suillia*. In certain heleomyzids an area of variable



Figs 24–29. Distal part of costal and subcostal cells of heleomyzid flies (costal armature omitted). **24,** *Scoliocentra helvola* Loew. **25,** *Leriopsis montana* McAlpine. **26,** *Anastomyza* sp. **27,** *Trixoscelis ornata* (Johnson). **28,** *Stuckenbergiella littoralis* Cogan. **29,** *Mayomyia diversipennis* Malloch.

width on the median part of the face is desclerotized or very lightly sclerotized, the fully sclerotized part being thus divided into two lateral plates. The desclerotization has proceeded farthest in *Mayomyia* in which the face is predominantly soft and without a visible line demarking it from the subcranial region (as in the Clusiidae). In the forms I place in the tribe Heleomyzini, the face has a differentiated median panel which is less sclerotized than the lateral parts, but the lower margin of the face is usually defined. This condition is similar to that of the Opomyzidae. In *Dichromya* and *Amphidysis* the sclerotized part of the face is restricted to a pair of deeply concave plates on the upper part into which the antennae fit in repose.

I use the term clitelliform to decribe the saddle-like contour of the face in many of the Rhinotorini. The surface in such insects forms a broadly rounded longitudinal ridge, which is lower in the middle and thus appears concave in profile.

In a few heleomyzid groups only (e.g. *Cinderella* and most species of Rhinotorini) the face is extended lateroventrally below the cheek on each side to form an almost vertical plate, the hypofacial. I have seen no heleomyzids in which the lower marginal part of the face is inflexed so that part of its surface faces ventrally, as in most forms referred to the superfamily Asteioidea (McAlpine, 1978).

Postgenal fold. Variation in the heleomyzid head capsule includes the development of a slight vertical ridge on the postgenal region, subtended anteriorly by a usually shallow groove. This modification, which I term the postgenal fold, is distinct in *Stuckenbergiella*, *Ollix* and the genera of Diaciini, while in the Heleomyzini it is often, but not always, distinguishable. In *Nephellum* the groove associated with the postgenal fold is very deeply incised. The postgenal fold most frequently occurs in forms with particularly deep cheek, but is absent in the Rhinotorini despite the depth of the cheek in various members.

Prosternum. The prosternum of the acalyptrate Diptera has been studied by Speight (1969) and its shape recorded for a number of heleomyzid genera. A difficulty in describing the shape of the prosternal plate (basisternum) derives from the fact that the margins of this sclerite often gradually give place to the surrounding membranous cuticle so that, in part, it may not be sharply outlined. Differences of interpretation are therefore sometimes possible.

In the heleomyzid prosternum, a shape found with high frequency through a wide range of genera approximates to that designated "B" by Speight (l.c.). This type is elongate, variably expanded anteriorly, and without precoxal bridges. It is possibly the groundplan type for Heleomyzidae, though direct evidence of this is not available. From the non-phylogenetic viewpoint it may be regarded as near the centre of diversity for the family.

In the tribe Heleomyzini, as defined below, the prosternum is often large and triangular, approximating to Speight's type V. Strongly sclerotized precoxal bridges (as in such families as Tanypezidae and Chloropidae) are not present in the forms I have examined, but often the cuticle at the anterolateral angle of the prosternum forms a ridge-like fold lying against the posterior cervical sclerite, which is in contact with the propleuron (Figs 40, 41). In many of this tribe, the anterior part of the prosternal plate is weakly sclerotized and there are reduction stages apparently resulting from desclerotization of this part.

Sclerotized precoxal bridges, connecting the prosternum to the propleuron of each side, occur in *Blaesochaetophora* and *Cinderella* (Figs 45, 46). In the latter there is a deeply impressed suture crossing the precoxal bridge.

Modifications of the pleurotergite. The pleurotergite is that part of the thoracic pleura lying behind the pteropleuron and above the metathoracic spiracle. The pleurotergite is sometimes considered to consist of a lower katatergite and an upper anatergite but these divisions are generally not well defined in acalyptrate flies.

Typically, the lower, anterior part of the pleurotergite forms a broadly convex raised ridge or callus running from the wing base to the metathoracic spiracle. Posteriorly, this ridge drops away to the level of the much less prominent, but sometimes convex, posterior part. This condition of the pleurotergite (Fig. 48) is seen in the majority of heleomyzid genera and in most other acalyptrate families. It is probably, therefore, the groundplan condition for the Heleomyzidae. For current purposes I term this the 'rhinotorine type of pleurotergite'.

In the tribes Allophylopsini and Cnemospathini, as here defined, there is a notable and fairly uniform modification of the pleurotergite (Fig. 49). The area corresponding to the convex ridge, in the above forms, is not more prominent than the posterior section and, on its lower part near the haltere, is not sharply distinguished from that section. On the upper part, towards the wing base, the two sections are separated by a deeply impressed suture, behind the upper end of which the posterior section forms a rounded gibbosity. These are the characteristics of what I designate as the 'allophylopsine type of pleurotergite'.

Though I have not found the allophylopsine type of pleurotergite in other heleomyzids, *Borboroides*, *Blaesochaetophora*, *Notomyza*, and *Epistomyia* show varying degrees of deviation from the rhinotorine condition, which could indicate that they are not far removed structurally from ancestral forms which gave rise to the Allophylopsini and Cnemospathini.

Costal armature. The presence of strong anterior to anteroventral spines at intervals among the smaller macrotrotrichia on the costa beyond the end of vein 1 has often been given as a diagnostic character of the family Heleomyzidae. This condition is particularly marked in many of the north-temperate genera of Heleomyzini, but Malloch (1933) and Hennig (1958) have rejected it as an essential criterion for inclusion in the family.

Variation in costal armature provides some characters which can be used in the internal classification of the family and I therefore illustrate the costa of a range of genera (Figs 50–65). The costal armature of *Zachaetomyia* is particularly characteristic in having an anterior series of stout, closely placed spines (Fig. 54), but the condition in *Diacia* (Fig. 53), which has the spines of the anterior series much more irregular in size, provides an intermediate state between that of *Zachaetomyia* and that of the Heleomyzini.

In *Prosopantrum* the post-tegular section of the costa terminates in 2 strong bristles, the humeral section has usually 2 series of long setulae, and the section bordering the second costal cell has at least 3 series of distinctly shorter setulae. *Notomyza* shows this pattern also. The allophylopsine genera (e.g. *Allophylopsis, Leriopsis* and *Austroleria* differ in having only one strong bristle terminating the post-tegular section and no differentiation in armature between the 2 succeeding sections, which usually have 3 series of short setulae. In *Epistomyia* the basal costal armature is markedly different again, despite resemblance in some other characters to *Prosopantrum* and *Notomyza*.

Taxonomic characters of the postabdomen. From published information and from my own studies it is apparent that there is great variation in male postabdominal structure in the Heleomyzidae. This may be somewhat greater than in most other acalyptrate families, though in several others the variation is also considerable. As this variation has been used as evidence for separating off several groups into separate families, we should ask the questions: Is the variation continuous or does it result in widely disjunct morphological types? Is the variation well correlated with variation in other organs, enabling a classification based on postabdominal characters to receive support from general characters?

Tergite 6 of the male abdomen is usually much reduced in size (sometimes absent) and without macrotrichia. In *Diacia*, *Dichromya*, *Amphidysis*, *Tephrochlamys*, *Heteromyza*, *Waterhouseia*, and *Notomyza* tergite 6 is well developed and often macrotrichose, though, except in *Notomyza*, it is considerably shorter than tergite 5. *Zachaetomyia*, *Orbellia* and *Pentachaeta* (Figs 74, 93) provide an intermediate condition in the development of tergite 6.

Sternite 6 of the male abdomen is usually somewhat reduced and located in a lateroventral position to the left of the median line. In *Notomyza* sternite 6 is absent, but in *Pentachaeta* it is reduced to an inconspicuous sclerotized strip on the left side. In *Tephrochlamys*, *Heteromyza*, and *Waterhouseia*, sternite 6 is ventral, symmetrical or almost so, and macrotrichose, but is considerably shorter than sternite 5. This might appear to be a character of great importance, but in *Orbellia* (see Griffiths, 1972: Fig 101) sternite 6 is rather large, macrotrichose, and located largely on the ventral surface, though it is asymmetrical and somewhat displaced to the left side. Thus *Orbellia* appears to link *Heteromyza* and *Tephrochlamys* to the rest of the Heleomyzini, to which they belong on the evidence of most characters including facial structure and shape of the prosternum. *Tephrochlamys rufiventris* (Meigen) also resembles certain typical heleomyzines in its synanthropy and wide distribution through human transportation. *Waterhouseia* resembles *Heteromyza* and *Tephrochlamys* in the sclerites of segment 6 of the male abdomen, and shares with *Heteromyza*, but not *Tephrochlamys*, the sexual dimorphism in size of the eye and postfrons. In other significant characters *Waterhouseia* differs entirely from the heleomyzine genera, and its relationship to them is remote.

I interpret the variation in disposition of the protandrial sclerites in Heleomyzidae as indicating that the primitive arrangement was very asymmetrical, but that there has been a trend towards symmetry in several lineages. Crampton (1942) has explained the asymmetry of protandrial sclerites in terms of the torsion of this region, which takes place during the circumversion process. Though this explanation has not gained universal acceptance, it appears to be the simplest theory to fit the facts, and no convincing alternative explanation has come to my attention.

In illustrating the arrangement of the sclerites and spiracles of the protandrium I utilize the protandrogram (Figs 66–98), a system of diagrammatic illustration devised by Steyskal (1957 and elsewhere). Segments 5 to 8 are shown as if split along the median ventral line and spread flat. In interpreting these diagrams it should be realised that some distortion is involved in representing a three-dimensional subject in one plane, and that the limits of some sclerites may not be sharply defined.

The form of the aedeagus is a further highly variable character in the Heleomyzidae. Sometimes it is long and strap-shaped as in *Scoliocentra villosa* (Meigen), *Neossos marylandicus* Malloch, *Diplogeomyza hardyi* McAlpine (1967) and most examined species of *Prosopantrum* (Edwards in Malloch 1933). In other examples the aedeagus is remarkably short, e.g. *Suillia ustulata* (Meigen), *Waterhouseia cyclops* Malloch, *Trixoleria maculata* McAlpine, and *Diplogeomyza immaculata* McAlpine. My comparative study of the genitalia of *Diplogeomyza* (McAlpine 1967) illustrates the fact that the aedeagus and the periphallic parts are often extraordinarily unstable above the species level, apparently because of selection pressures which operate in closely related sympatric species.

The structure of the female postabdomen has also been used by Griffiths (1972) as evidence for separating *Neossos* (= *Chiropteromyza*) and *Prosopantrum* widely from the Heleomyzidae, and placing them in the "Prefamily Tephritoinea". The groundplan conditions of the female postabdomen include: "7th and 8th segments (♀) elongate, forming slender retractile ovipositor: 8th sternum divided into paired longitudinal sclerites".

These conditions of the female postabdomen are present in four species of the genus *Diplogeomyza* (my group 2, McAlpine 1967), but here they clearly represent

a development within part of the genus. The species of the other three species-groups of *Diplogeomyza* do not have segments 7 and 8 elongate, and sternite 8 is entire or partly divided. Hennig (1969) also records great variation in the female postabdomen between species of the genus *Cephodapedon*. Turning to *Prosopantrum flavifrons* Tonnoir & Malloch, I find segments 7 and 8 to be quite short, not at all in conformity with the theoretical ground plan of Tephritoinea. The same segments in *Neossos marylandica* Malloch are little more elongate than in *P. flavifrons*, and in neither species are they as elongate as in *Diplogeomyza diaphora* Hendel. In his discussion of these characters, Griffiths admits that the 'Chiropteromyzidae and Cnemospathidae' do not fully possess the female postabdominal characters of the Tephritoinea. I point out that in these characters, they are not differentiated from the Heleomyzidae. Their position in the Tephritoinea must then depend on the structure of the aedeagus. But the elongate distal part of the aedeagus in *Neossos* is essentially similar to that of *Scoliocentra*, a typical member of the Heleomyzidae, which is classified in the prefamily Anthomyzoinea by Griffiths.

I conclude, from examination of numerous genera and species, that diversification of the male and female postabdominal structures has occurred at various stages of evolutionary radiation in the Heleomyzidae, that the characters of these structures are often highly unstable, that some kinds of modification can be duplicated in different lineages, and that these characters should not be used in higher classification without support from other kinds of characters.

Tribes and Genera of Heleomyzidae

Tribe Heleomyzini Westwood, 1840 (as Helomyzides) (= Heteromyzides Fallén, 1820; Blepharopterina Loew, 1862; Leriinae Czerny, 1904). *Acantholeria* Garrett, 1921. *Aecothea* Haliday, 1838 (= *Neoecothea* Peterson and Gill, 1982). *Anorostoma* Loew, 1862. *Anymphochaeta* Czerny, 1924. *Anypotacta* Czerny, 1924. *Desertoleria* Gorodkov, 1962. *Eccoptomera* Loew, 1862. *Heleomyza* Fallén, 1810 (= *Helomyza* Fallén, 1820 (emend.); *Leria* Robineau-Desvoidy, 1830; *Blephariptera* Macquart, 1835). *Heteromyza* Fallén, 1820 (= *Thelida* Robineau-Desvoidy, 1830). *Kiboleria* Lindner, 1956. *Lutomyia* Aldrich, 1922. *Morpholeria* Garrett, 1921 (= *Spanoparea* Czerny, 1924). *Neoleria* Malloch, 1919. *Oldenbergiella* Czerny, 1924. *Orbellia* Robineau-Desvoidy, 1830. *Pseudoleria* Garrett, 1921. *Schroederella* Enderlein, 1921. *Scoliocentra* Loew, 1862 (= *Amoebaleria* Garrett, 1921; *Chaetomus* Czerny, 1924; *Gymnomus* Loew, 1863; *Trichochlamys* Czerny, 1924). *Tephrochlaena* Czerny, 1924. *Tephrochlamys* Loew, 1862.

Tribe Tapeigastrini Séguy, 1952 (as Tapigasterinae). *Tapeigaster* Macquart, 1847. ? *Ollix* n.gen.

Tribe Suilliini Wahlgren, 1917 (as Suilliinae). *Suillia* Robineau-Desvoidy, 1830 (= *Allophyla* Loew, 1862). *Porsenus* Darlington, 1908.

Tribe Diaciini n.tr. (= Thyreophorellinae Czerny, 1927b, invalid name). *Diacia* Wiedemann, 1830 (= *Thyreophorella* Hendel, 1910). *Dichromya* Robineau-Desvoidy, 1830. *Amphidysis* n.gen.

Tribe Zachaetomyiini n.tr. *Zachaetomyia* Malloch, 1933.

Tribe Blaesochaetophorini n.tr. *Blaesochaetophora* Czerny, 1904 (= *Dihoplopyga* Malloch, 1933).

Tribe Borboropsini Griffiths, 1972 (as Borboropsidae). *Borboropsis* Czerny, 1902.

Tribe Chiropteromyzini Frey, 1952 (as Chiropteromyzidae). *Neossos* Malloch, 1927 (= *Chiropteromyza* Frey, 1952; *Ornitholeria* Frey, 1930).

Tribe Cinderellini n.tr. *Cinderella* Steyskal, 1959.

Tribe Epistomyiini n.tr. *Epistomyia* Malloch, 1933.

Tribe Cnemospathini Enderlein, 1938 (as Cnemospathidae). *Prosopantrum* Enderlein, 1912 (= *Acrostichalia* Tonnoir & Malloch, 1927; *Cnemospathis* Enderlein, 1938).

Tribe Allophylopsini McAlpine, 1967. *Allophylopsis* Lamb, 1909 (= *Huttonomyia* Malloch, 1922). *Allophylina* Tonnoir & Malloch, 1927. *Leriopsis* McAlpine, 1967. *Trixoleria* McAlpine, 1967. *Austroleria* McAlpine, 1967. *Diplogeomyza* Hendel, 1917.

Tribe Borboroidini n.tr. *Borboroides* Malloch, 1925. *Heleomicra* n.gen.

Tribe Notomyzini Griffiths, 1972 (as Notomyzidae). *Notomyza* Malloch, 1933.

Tribe Gephyromyzini n.tr. *Gephyromyza* Malloch, 1933. *Paraneossos* Wheeler, 1955. *Cephodapedon* Malloch, 1933.

Tribe Nephellini n.tr. *Nephellum* n.n. for *Nephoneura* Malloch, 1933 (not M'Lachlan, 1871).

Tribe Rhinotorini Williston, 1896 (as Rhinotorinae). *Anastomyza* Malloch, 1933. *Apophoneura* Malloch, 1933. *Rhinotoroides* Lopes, 1934. *Rhinotora* Schiner, 1868. *Neorhinotora* Lopes, 1934. *Zentula* n. gen. *Cairnsimyia* Malloch, 1931.

Tribe Pentachaetini n.tr. *Pentachaeta* n.gen. *Dioche* n.gen.

Tribe Trixoscelidini Hendel, 1916 (as Trixoscelidae). *Trixoscelis* Rondani, 1856 (= *Trichoscelis* auct. not Amyot & Serville, 1843, Hemiptera; *Diastata, sensu* Malloch, 1931, not Meigen,1830; *Spilochroa* Williston, 1907; *Zagonia* Coquillett, 1904). *Paratrixoscelis* Soós, 1977. *Stuckenbergiella* Cogan, 1971. *Psiloplagia* Czerny, 1928.

Tribe Fenwickiini n.tr. *Fenwickia* Malloch, 1930. *Xeneura* Malloch, 1930. *Aneuria* Malloch, 1930.

Tribe Waterhouseini n.tr. *Waterhouseia* Malloch, 1936.

Tribe Mayomyiini n.tr. *Mayomyia* Malloch, 1934.

Removed from family Heleomyzidae. *Heloclusia* Malloch, 1933 (to Pseudopomyzidae: McAlpine, 1966; Hennig, 1969). *Apetaenus* Eaton, 1875 and *Listriomastax* Enderlein, 1909 (to Tethinidae: Griffiths, 1972). *Tethinosoma* Malloch, 1930 (to Tethinidae: McAlpine, 1967).

Nomenclatural Notes.

Because of general usage, the name Helomyzides Westwood, 1840, is treated as having priority over Heteromyzides Fallén, 1820, though an application to the International Commission on Zoological Nomenclature is necessary to formalise the position. A ruling requiring that Helomyzides be treated as if published in 1820, just prior to Fallén's work of that date, would seem advantageous. This would also preserve the superfamily name Heleomyzoidea over Sphaeroceroidea (based on Sphaeroceridae Macquart, 1835), and, in the event of the families Heleomyzidae and Sphaeroceridae being combined, preserve the family name which has a much greater period of continuous usage, and which covers a greater range of divergent types (though probably fewer species).

The application of Article 40 of the International Code of Zoological Nomenclature has here been attempted for family group names. Thus, the name Thyreophorellinae Czerny (1927b) is rejected as a name not in general usage based on a generic name synonymized before 1961. On the other hand, the name Cnemospathidae Enderlein (1938), also based on a generic name rejected as a synonym before 1961, is considered available in view of its usage in two influential works (Brues, Melander & Carpenter, 1954, and Griffiths, 1972), and of the absence of an alternative name. The name Chiropteromyzidae Frey, 1952, is available, as the synonymy of its type-genus was not recognized till well after 1960 and there is no available alternative.

In accordance with Article 29(d) of the Code, the incorrectly formed stem cnemospath- is incorporated into the tribal name Cnemospathini, rather than the otherwise correct cnemospathid-.

I do not give complete generic synonymy in the above list, but give those synonyms most likely to be encountered in literature of this century. Further synonymy is given by Czerny (1924) and Gill (1965).

Nephellum is a new replacement name for *Nephoneura* Malloch, 1933, preoccupied by *Nephoneura* M'Lachlan, 1871 (Neuroptera, Ascalaphidae). It has the same type-species as Malloch's genus, viz. *Nephellum dendrophilum* (Malloch), n.comb.

Key to Tribes of Heleomyzidae

1. Face with pair of well sclerotized lateral plates separated by a lightly sclerotized or desclerotized median strip of variable width.....2

——Face uniformly sclerotized (in some minute forms weakly so) across whole width, at least on upper part.....4

2. Mesopleural bristle long; 3 fronto-orbital bristles present; vein 4 curved forwards to meet vein 3 at apex... temperate S. America.....Mayomyiini

——Mesopleural bristle absent or quite short; fewer than 3 fronto-orbital bristles present; vein 4 not thus curved.....3

3. Facial plates forming pair of deep, rounded oval pits, not approaching vibrissae; ptilinal suture laterally passing behind and below insertion of vibrissa; cheek and parafacial with fingerprint sculpture; a horizontal series of more than 2 bristles present on upper part of sternopleuron... W. Australia and S. America.....Diaciini (part)

——Facial plates only slightly concave, following contour of parafacial to near level of vibrissa; ptilinal suture discontinued far above vibrissa; cheek and parafacial without fingerprint sculpture; 1 or 2 upper sternopleural bristles only... Holarctic and Afrotropical Regions, introduced elsewhere. .....Heleomyzini.

4. Mesopleural bristle well developed.....5

——Mesopleural bristle absent, though mesopleuron sometimes haired or setulose. 8

5. Fronto-orbital bristles 2, not reclinate but strongly flexed outwards; vein 6 attaining wing margin... Holarctic Region.....Borboropsini

——Fronto-orbital bristles otherwise disposed; vein 6 not attaining margin.....6

6. 2 fronto-orbital bristles present, and at least the posterior one reclinate, or these bristles absent; costa with pair of strong spines terminating section basad of costal break... widespread, not in Australia or New Zealand. .....Trixoscelidini (part)

——3 fronto-orbital bristles present, all reclinate; costa with one spine (sometimes weak) terminating section basad of costal break... Australia and New Zealand.....7

7. 1 preapical dorsal bristle on each tibia; costa beyond vein 1 with short, spaced spines among the anteroventral series of setulae; postfrons not sexually dimorphic... New Zealand.....Fenwickiini

——Preapical dorsal tibial bristles absent; costa beyond vein 1 without spaced spines; postfrons of male narrowed... Australia.....Waterhouseiini

8. Prosternum connected to propleuron on each side by a sclerotized precoxal bridge (in *Cinderella* the bridge is often not visible without decapitation but the very broad prosternum, filling space between coxae, is often apparent).....9

——Prosternum relatively narrow, without precoxal bridges.....10

9. Vein 6 curved forwards distally so that its unpigmented distal part is subparallel with vein 5; fronto-orbital bristles directed outwards; ptilinal suture transverse, concealing lunule; cerci of female consisting of pair of basal plates, from each of which arises a curved, shining process ending in a large spine... temperate S. America.....Blaesochaetophorini

——Vein 6 only slightly curved, not becoming subparallel with vein 5; fronto-orbital bristles reclinate and slightly sloped outwards; ptilinal suture arched above level of antennal sockets, exposing lunule; cerci of female simple... Americas.....Cinderellini

10. Fronto-orbital bristles 3, reclinate... Americas (principally temperate South America).....Gephyromyzini

——Fronto-orbital bristles 1 or 2.....11

11. Arista inserted no closer to base than to apex of segment 3 (viewed from above); antenna porrect; not more than 3 pairs of dorsocentral bristles present; postgenal fold absent; either central cheek bristle strongly developed or wing extensively spotted... Australia, New Guinea, Americas.....Rhinotorini

——Insertion of arista closer to base than to apex of segment 3; antenna more or less decumbent (except in Nephellini with 5 pairs of dorsocentrals); other characters variable.....12

12. Fronto-orbital plate short, sloping mesad away from eye margin, and bearing one strong bristle only; costa with strong, spaced spines; subcosta complete, distally diverging from vein 1... widespread, absent from southern Neotropical and Australian Regions.....Suilliini

——Fronto-orbital plate parallel with eye margin, or bearing more than one bristle; other characters variable.....13

13. Scutellum haired dorsally; vein 7 relatively well developed, curved; femora with thickened ventral spines... Australia.....Tapeigastrini

——Scutellum usually not haired; vein 7 short or absent; femora not strongly spined ventrally.....14

14. Mid and hind tibiae with numerous dorsal bristles, some on basal half; costa near middle usually with numerous, rather crowded, short, thick spines among the hairs; size large, wing over 6 mm long... South America.....15

——Mid and hind tibiae without dorsal bristles on basal half; costal spines, if differentiated, more widely spaced; size variable.....16

15. Sclerotized part of face deeply excavated; prosternum broader than long. .....Diaciini (part)

——Face not deeply excavated; prosternum much longer than broad. .....Zachaetomyiini

16. 5 pairs of dorsocentral bristles present....17

——Less than 5 pairs of dorsocentral bristles present....20

17. Mesopleuron coarsely setulose; propleural bristle rather short; veins 2 and 3 apically divergent... Palearctic Region....Trixoscelidini (part)

——Mesopleuron bare; propleural bristle long, reaching as far as humeral callus; veins 2 and 3 apically convergent or parallel... south temperate regions....18

18. Costa with spaced spines; vein 6 reaching almost to margin; several pairs of acrostichal bristles present; central cheek bristle absent... temperate S. America....Epistomyiini

——Costa without spaced spines; distal section of vein 6 discontinued at about 3/4 of its extent to margin; acrostichal bristles absent; central or central-marginal cheek bristle present....19

19. Postgenal fold forming a deeply incised groove; palpus very short; preapical dorsal tibial bristles absent....Nephellini

——Postgenal fold absent; palpus normal; each tibia with one preapical dorsal bristle....Pentachaetini (part)

20. Pleurotergite of the allophylopsine type; mid femur with one strong apical to subapical posterior bristle....21

——Pleurotergite of the rhinotorine type; apical to subapical posterior bristle on mid femur usually rather weak, absent, or one of a series....22

21. Mid tibia with pair of strong, approximated dorsal bristles somewhat beyond middle, and no other bristles but the terminal ones; at most, only the prescutellar pair of acrostichals present... Australia and New Zealand. ....Allophylopsini

——Mid tibia with one dorsal bristle at one quarter to one third length of tibia from apex, and one or 2 subdorsal bristles between this and apex; several pairs of acrostichal bristles more or less distinguished from adjacent hairs... temperate South America, introduced elsewhere....Cnemospathini

22. Propleural bristle well developed; vein 7 visible as a short crease in membrane beyond alula... Holarctic Region....Chiropteromyzini

——Propleural bristle vestigial or absent; vein 7 absent... south temperate regions. 23

23. Cheek with at least one long bristle near centre; second basal and anal cells very small, about 0.1 of length of discal cell; distal section of vein 6 running much closer to postero-basal margin of anal region of wing than to vein 5... temperate South America....Pentachaetini (part)

——Central cheek bristles absent; second basal and anal cells normal; distal section of vein 6 in normal position....24

24. Mid tibia with only one strong preapical dorsal bristle in addition to terminal bristles; ♂ postabdomen with well developed setose tergite 6 and no sternite 8... temperate South America....Notomyzini

——Mid tibia with two preapical dorsal and at least one anterior bristle, or with only the terminal bristles; ♂ postabdomen: tergite 6 much reduced or absent; sternite 8 large... Australia....Borboroidini

Tribe Heleomyzini

Face with differentiated sclerotized lateral plates extending to near, or below, level of vibrissa; ptilinal suture laterally discontinued far above vibrissa; a vertical or oblique postgenal fold separating setulose postgenal region from central part of cheek; fronto-orbital bristles 1 or 2, more or less reclinate, on rather short fronto-orbital plates; prelabrum narrow; proboscis rather short, with broad or moderately developed labella, antenna porrect or decumbent, with segment 3

rounded; propleural bristle long, solitary; mesopleural bristle absent; 1 or 2 strong sternopleural bristles present; dorsocentral bristles usually 3 or more; prosternum usually broadly triangular with precoxal bridges at most only weakly indicated; mid femur usually with one or more anterior bristles; tibiae with distinct preapical bristles; costa incised only at end of subcosta, usually with strong spaced spines; subcosta complete and distally diverging from vein 1; vein 6 complete; vein 7 distinguishable; anal crossvein strongly convexly curved; male postabdomen diverse (see below); female with separately sclerotized, often elongate cerci.

The taxonomic position of *Heteromyza* and allied genera has been a matter of disagreement. Czerny included these in the subfamily Heleomyzinae, without special segregation, and has been followed by most taxonomists. Gorodkov (1971) stated, in connection with his study of postabdominal morphology: "Heteromyzidae Fallén is a taxon at least of the subfamily range." Griffiths (1972) separated *Heteromyza* and *Tephrochlamys* in the family Heteromyzidae, placing this and the Tanypezidae (s.l.) as the only families of his prefamily Tanypezoinea. Hackman (1977) also gave Heteromyzidae separate family rank from Heleomyzidae.

In males of *Heteromyza* and *Tephrochlamys* the symmetrical segment 6, with relatively large tergite and sternite, has been considered a remarkable departure from the condition in other heleomyzine genera. However, I find sternite 6 of *Heteromyza rotundicornis* (Zetterstedt) to be only approximately symmetrical (Fig. 68), a condition which could be explained by selection for functional symmetry acting upon a primarily asymmetrical complex.

In males of many typical Heleomyzini tergite 6 is reduced to a narrow transverse strip or absent, sternites 6 and 7 are asymmetrically placed, at least the latter is joined to sternite 8, and the seventh right spiracle is located ventrally, most often to the left of the median ventral line [*Scoliocentra* (Fig. 67), *Heleomyza* (Gorodkov, 1962b, as *Leria*), *Pseudoleria* (my observations), *Neoleria* (Crampton, 1942, Gorodkov, 1959), *Anorostoma* (Crampton, 1942), *Aecothea* (Gorodkov, 1959)]. Gorodkov (1971) discusses variation in this series. *Orbellia* (Hennig, 1958: Fig. 234; Czerny, 1927a: Fig 26, whole insect; my observations), and *Desertoleria* (Gorodkov, 1962a) have a rather large quadrate, setulose tergite 6 and a large but asymmetrical and somewhat laterally displaced sternite 6. They could be considered to be intermediate between the *Heteromyza* configuration and that of the more typical heleomyzines. *Oldenbergiella* is another genus with well developed tergite 6 and asymmetrical protandrial sternites (Czerny, 1924; Gorodkov, 1971). I conclude that the Heleomyzini, however defined, is a group showing considerable variation in the protandrial sclerites.

It might be inferred from Griffiths' characterisation of the prefamily Tanypezoinea that the *Heteromyza* complex shares with the Tanypezidae the modifications of the 'ovipositor' segments found in that family. This, however, is not so. The female postabdominal segments of *Heteromyza* and *Tephrochlamys* are not very unlike those of *Scoliocentra* and *Heleomyza*, though some other heleomyzines, e.g. *Aecothea*, differ considerably. The cerci of female *Heteromyza* and *Tephrochlamys* are separate, articulated structures as in other heleomyzines examined. In female Tanypezidae there are no distinguishable cerci.

The absence of the seventh pair of abdominal spiracles is a significant condition shared by Tanypezidae and 'Heteromyzidae', according to Griffiths. I find it to occur in both sexes of the heleomyzid genus *Diplogeomyza* in all species groups (McAlpine, 1967), and in both sexes of at least some species of *Trixoscelis* (Hennig, 1958). The seventh pair of spiracles is absent in males of *Prosopantrum*, *Notomyza*, *Austroleria*, and in a part only of the genus *Borboroides*. In the male of *Zachaetomyia* the spiracles of segment 7 are reduced in size. The fact that the condition of the seventh pair of spiracles is not recorded for females of these and other heleomyzid genera seems mainly due to lack of investigation. Undoubtedly the loss of these spiracles is a very simply achieved evolutionary step which has taken place in numerous lineages.

The costal spination of the *Heteromyza* complex is rather variable and differs from that of most heleomyzines only in degree of reduction of major spines. In *Orbellia*, the position of which in the Heleomyzini is accepted, they are also much reduced. The pattern of costal spination in *Heteromyza rotundicornis* (Fig. 32) lies well within the range of variation for typical heleomyzines.

Sexual dimorphism in the width of the postfrons occurs within this complex only in certain species of *Heteromyza*. It is found elsewhere in the Heleomyzidae in *Waterhouseia*, which appears to have quite different affinities despite its *Heteromyza*-like male abdominal segment 6. In the Tanypezidae, sexual dimorphism of the head occurs in only some species of one of the two subfamilies (viz. Tanypezinae and Strongylophthalmyiinae) and may well not be a groundplan character for the family. It is possible that the correlation of sexual dimorphism of the head and approximate symmetry of segment 6 is brought about by a common behavioural trait in its bearers, perhaps aerial mating (see Downes, 1969, for discussion of ocular dimorphism in this connection).

In *Tephrochlamys* and *Heteromyza*, the facial structure is identical to that of *Heleomyza* and allied genera, though the Tanypezidae also have the face desclerotized medially. *Tephrochlamys rufiventris* (Meigen) and *Heteromyza rotundicornis* (Zetterstedt) have a typical heleomyzine prosternum of broadly triangular shape, with only weak indications of precoxal bridges. The prosternum of *Tephrochlamys* resembles in remarkable detail that of such typical heleomyzines

as *Pseudoleria* (compare Figs 41 and 40). Particularly notable is the presence of a lightly sclerotized lateral supernumerary sclerite, and, in both examples, the anterior part of the plate is little sclerotized with rather indefinite limits.

Griffiths (1972) notes the characteristic structure of the spermathecae in *Tephrochlamys rufiventris* (Meigen). I have not made a study of the spermathecae in the Heleomyzini, but among other heleomyzids there are similarities in spermathecal structure (M.A. Schneider's unpublished studies). These are noted for *Borboroides* (one undescribed species investigated) and for a number of species of *Diplogeomyza*, which have two of the three spermathecal vesicles arising directly from the swollen apex of the one common duct, the sclerotized lining of the vesicle continuing into the apical part of the duct to a varying extent. The closest approach to that of *T. rufiventris* is probably found in *Diplogeomyza hardyi* McAlpine. All these forms have 3 spermathecal vesicles according to Schneider's studies. Hennig (1958) records *Tephrochlamys rufiventris* as having 2 spermathecae, but the one specimen I examined has 3, as given by Griffiths, though the form of the single spermatheca agrees with Hennig's Fig. 27.

I conclude that, in view of the detailed morphological agreement, the *Heteromyza* complex is best retained in the tribe Heleomyzini, and that its removal from the family Heleomyzidae can only be justified by placing an undue emphasis on the male postabdominal characters.

Tribe Tapeigastrini

Fronto-orbital plate short and parallel with eye-margin, with one or two somewhat reclinate, often weak bristles; prelabrum reduced; antenna decumbent; arista with very short hairs only, inserted sub-basally on segment 3; propleural and mesopleural bristles absent; 1 sternopleural bristle present; 1 or 2 dorsocentral bristles present; scutellum with 2 pairs of bristles, the anterior pair a little in front of middle of length, and numerous short hairs; all femora with strong ventral spines; preapical dorsal tibial bristle usually rather weak or absent; costa not weakened just beyond humeral crossvein; subcosta complete, distally diverging from vein 1; anal crossvein with sigmoid curvature, almost transverse; vein 6 generally long, reaching margin in some species; vein 7 present; male postabdomen (McAlpine & Kent, 1982) with tergite 6 reduced, sternites 6 and 7 laterally placed.

I provisionally refer here the new genus *Ollix* which, while resembling *Tapeigaster* in several characters, also bears some resemblance to *Amphidysis* of the tribe Diaciini. *Ollix* and *Tapeigaster* share the following notable characters: face concave; segment 6 of arista gradually thickened basally (in contrast to Diaciini) and segment 5 short (in contrast to Zachaetomyiini); anal cell angular posterodistally (*Tapeigaster subglabra* has the anal cell very similarly formed to that of *Ollix cupella*); vein 6 reaching approximately to margin (some exceptions in *Tapeigaster*); vein 7 visible; prosternum narrow; costal break at end of subcosta consisting of weakening of vein for a short distance rather than a definite incision; preapical tibial bristles weaker than usual in the family, and located closer to apex of tibia. *Ollix* differs from *Tapeigaster* in the more numerous dorsocentral and sternopleural bristles, absence of hairs on the scutellum, different structure of the subcostal cell, and indication of some irregularly enlarged costal bristles.

The placement of *Tapeigaster* in the Scatophagidae (correctly Scathophagidae) by Bezzi (1923) and Séguy (1934, 1952) is without any sound basis. The genus is clearly acalyptrate and was first referred to the heleomyzid alliance by Hennig (1958).

Schneider (1982) provides information on the male and female reproductive systems of *Tapeigaster* species.

Tribe Suilliini

Fronto-orbital plate short, sloping away from eye anteriorly, with only one reclinate bristle (in recent forms); antenna somewhat decumbent, with arista inserted sub-basally on segment 3; propleural bristle minute; mesopleural bristle absent; one sternopleural bristle present; dorsocentral bristles 4 or 5 (only one in the little-known *Porsenus*); scutellum with 2 pairs of strong marginal bristles, with or without short hairs; tibiae each with one preapical dorsal bristle; costa with spaced anterior spines between veins 1 and 2, not weakened beyond humeral crossvein; subcosta complete, diverging from vein 1; vein 6 rather long but incomplete; vein 7 usually present as a trace; male postabdomen with tergite 6 much reduced; sternites 6 and 7 more or less fused with sternite 8 on left side.

Suillia (including *Allophyla*) is a large well known genus, but further study of the little-known nearctic genus *Porsenus* is desirable.

Though this tribe is principally holarctic, *Suillia* has penetrated southwards to Colombia and Ecuador (new records for South America, CNC material), to South Africa and Madagascar in the Afrotropical Region (Cogan, 1971), and to Java in the Oriental Region (Hackman, 1977).

Hennig (1965) refers two fossil species to this group (as subfamily Suilliinae). These are placed respectively in *Protosuillia* Hennig and provisionally in *Suillia*.

Tribe Diaciini n.tr.

Cuticle of thorax and abdomen black (cuticle often more or less concealed by grey pruinescence), contrasting with the largely ochraceous to orange head capsule; postfrons anteriorly produced horizontally over ptilinal suture; eye surface much reduced, or slightly so in *Amphidysis*; face below antennal sockets with pair of sclerotized, deeply concave plates, which are separated on median line, or, in *Diacia*, completely

fused, the rest of the face largely desclerotized or, in *Diacia*, with prominent, sclerotized epistomal margin; cheek and parafacial with fingerprint sculpture (weak and concealed by pruinescence in *Diacia*); postgena with vertical fold; ptilinal suture laterally reaching behind and below insertion of vibrissa; fronto-orbital bristles 2, rather close together on posterior half of postfrons, posterior one somewhat reclinate, anterior one somewhat proclinate; vibrissa situated well above oral angle, rather weak except in male of *Diacia*; arista glabrous or very minutely haired, with short thick segment 5, and segment 6 shortly bulbous basally; propleural and prostigmatal bristles both developed, or, in *Amphidysis*, more than one propleural and no prostigmatal bristle; mesopleuron bare or, in *Dichromya*, coarsely setulose; more than 2 upper sternopleural bristles present, or, in *Diacia*, only one; scutellum setulose dorsally, except in *Diacia*; prosternum without precoxal bridges, broad except in *Amphidysis*; costa not noticeably weakened near humeral crossvein, without thickening and flexure at subcostal break; subcosta complete, not much diverging from vein 1 distally; vein 6 long; vein 7 absent, or, in *Amphidysis*, quite long; male postabdomen (Hennig, 1971; author's observations) with tergite 6 larger than in most heleomyzid groups, well sclerotized, setulose, resembling tergite 5 in texture; sternite 6 displaced towards left side; sternite 7 lateral; aedeagus with slightly elongate, sclerotized basiphallus, and largely membranous distiphallus, which is elongate in *Amphidysis*, very broad in *Dichromya* and *Diacia*; female postabdomen with cerci joined by a membrane for their entire length.

The three genera of this tribe, *Diacia*, *Dichromya*, and *Amphidysis*, appear to be closely related on the basis of a considerable number of characters, not all shared between all genera as each genus has some peculiarities. I believe that *Amphidysis* forms a sister group to the other two genera, as evidenced by the following, probably apomorphic characters shared between *Diacia* and *Dichromya*: prosternum broadened; vein 6 incomplete; vein 7 absent. This grouping is supported by geographic distribution (*Amphidysis* in Western Australia, *Diacia* and *Dichromya* in South America). On the other hand there are remarkable similarities between *Dichromya* and *Amphidysis* in facial structure, sculpture of the cheek and parafacial, number of sternopleural bristles, and hairing of the scutellum, not shared with *Diacia*. This character distribution could be accounted for either by a complex convergence between *Dichromya* and *Amphidysis*, or, in some characters, regression towards the apparently primitive condition in *Diacia*.

Hennig (1971) has presented evidence for viviparity in *Dichromya*.

Tribe Zachaetomyiini n.tr.

General coloration fulvous with darker abdomen (in contrast to Diaciini); face evenly sclerotized, not deeply excavated, but with transverse groove just above lower margin (thus more as in Allophylopsini than in Diaciini); fronto-orbital plate with 2 long, outwardly directed bristles; ptilinal suture extending close behind and below insertion of vibrissa; arista with subcylindrical, elongate segment 5; segment 6 only slightly thickened basally, with numerous short hairs, the longer ones about as long as basal diameter of segment; propleural and prostigmatal bristles well developed; mesopleuron bare; usually 3 sternopleural bristles present; dorsocentral bristles 1 + 4; pleurotergite somewhat approaching the allophylopsine condition, with upper part most convex next to the narrow groove separating it from lower part; scutellum without hairs or setulae, with bristles of lateral pair inserted behind middle of length of scutellum; prosternum narrow; fore tibia with one preapical dorsal bristle only; other tibiae with additional bristles including long dorsal one near base, bristling more developed in male; costa slightly weakened just beyond humeral crossvein, with slight thickening and flexure at subcostal break, with short, spaced spines at rather short intervals anterodorsally, and more numerous short, anterior to anteroventral spines; subcosta complete, a little divergent from vein 1; vein 6 almost straight, reaching approximately to margin; vein 7 absent; anal crossvein recurrent, making anal cell scarcely angular posterodistally; male postabdomen with tergite six short but well sclerotized, asymmetrical; sternites 6 and 7 laterally placed; left spiracle 7 located in sternite, other spiracles of segments 6 and 7 located in membrane; sternite 8 well developed, with long bristles posteriorly; surstylus articulated basally; hypandrium with 2 pairs of gonites; aedeagus not very elongate, with distinct basiphallus and broad, anteriorly reflexed distiphallus; cerci widely separated; female postabdomen with segments behind segment 5 progressively shortened; cerci rather elongate, straight, articulated basally, with hairs and pruinescence (thus contrasting with cerci of Blaesochaetophorini).

This tribe may be related to the Blaesochaetophorini and Diaciini, but differs from the former in the structure of the hypofacial, prosternum, vein 6, and female cercus, and from the latter in structure of the face, arista, costa, and anal crossvein. The pleurotergite is rather different from that of both groups.

Tribe Blaesochaetophorini n.tr.

Fronto-orbital plate of moderate length, approximated to eye-margin, with one or 2 outwardly curved bristles; antenna porrect or almost so; arista with numerous short hairs, inserted sub-basally on the broadly rounded segment 3; segment 5 of arista cylindrical, long and rather stout; prelabrum strongly developed; propleural bristle variably developed; mesopleural bristle absent; 2 to 4 sternopleural bristles present, the foremost set higher than hindmost; dorsocentral bristles 0 + 3 or 1 + 3; scutellum without hairs, often with basal pair of bristles longer than apical ones and situated behind middle of scutellum;

prosternum with well developed precoxal bridges; mid tibia with a strong preapical anterodorsal bristle and sometimes series of posterodorsal bristles; costa more or less weakened just beyond humeral crossvein, with long spaced spines, or spines absent beyond end of vein 1; subcosta rather close to vein 1 distally, distinct throughout or obsolete distally; vein 6 gradually fading and curving forwards to become parallel with vein 5 distally, not reaching margin; vein 7 absent; male postabdomen, so far as known, with variably reduced tergite 6; sternites 6 and 7 asymmetrical, sometimes reduced; one pair of articulated surstyli present; aedeagus with prominent, elongate basiphallus and elongate distiphallus directed basad from anterior surface of basiphallus; cerci widely separated; cercus of female elongate, curved, glabrous with compressed terminal spine, basally fused with last visible tergite, resembling cercus of *Canace* (family Canacidae).

It is possible that this tribe is somewhat related to the Zachaetomyiini and Diaciini as all these include at least some forms with strong bristles on much of the length of the mid tibia, and, in all, the ptilinal suture extends close behind the vibrissa. The basic pattern of the fronto-orbital bristles appears to be 2 outwardly directed elements in both Zachaetomyiini and Blaesochaetophorini.

Malloch (1933) recognized the genera *Blaesochaetophora*, with only included species *B. picticornis* (Bigot), and *Dihoplopyga*, which he established to include *D. polita* Malloch (type-species) and *D. norma* Malloch. For *Dihoplopyga* he states:

"Very similar ... to *Blaesochaetophora*, but lacking postero-dorsal bristles on mid tibiae, well-developed propleural and stigmatal bristles, and well-developed costal bristles beyond apex of first vein. There is but one humeral present, and no additional bristle near the long presutural sublateral one; the scutellar bristles are not crowded together on less than the apical half."

A further point of difference is the presence of four pairs of dorsocentral bristles in the described species referred to *Blaesochaetophora* and three pairs in those referred to *Dihoplopyga*.

On examining about 800 specimens of this tribe I find that all these supposed generic characters break down. *Blaesochaetophora picticornis* appears to be simply that species, of a variable complex, with greatest hypertrophy of the bristling, and, if my estimation of specific limits is correct, it is itself somewhat variable in almost every character. Some specimens, possibly diminutives of *B. picticornis*, have the dorsal submedian bristles present on one mid tibia and absent on the other. An apparently undescribed species has four pairs of dorsocentral bristles in combination with two subequal pairs of fronto-orbitals, a vestigial propleural, the lateral pair of scutellars behind middle of scutellum and no submedian dorsal bristles on the mid tibia. Its generic position would depend on which characters are weighted most heavily. Some small specimens of *B. picticornis* have the costal spines between veins 1 and 2 no more differentiated than in large specimens of *D. polita*.

I am convinced that the only reasonable course is the union of these two genera. Thus *Dihoplopyga* Malloch, 1933, becomes a new synonym of *Blaesochaetophora* Czerny, 1904, and the species *D. norma* and *D. polita* are transferred to *Blaesochaetophora*.

Tribe Borboropsini.

Fronto-orbital plate moderately long with 2 subequal, outwardly flexed bristles; cheek bristles long but not forming a horizontal series; antenna decumbent with short segment 2 and broadly rounded segment 3; arista inserted sub-basally on segment 3, with segment 5 cylindrical and segment 6 not markedly swollen basally; propleural bristle moderately developed; mesopleural bristle present; one strong and one or more shorter sternopleural bristles present; dorsocentral bristles several, diminishing in size anteriorly; scutellum without hairs; preapical dorsal tibial bristles variable, often rather weak; costa between veins 1 and 2 with short, spaced spines, scarcely longer than hairs, or these spines indistinguishable; subcosta complete, not much diverging from vein 1 distally; anal crossvein curved; vein 6 reaching margin; vein 7 forming an unpigmented fold in membrane; male postabdomen (Griffiths, 1972) with tergite 6 reduced, sternites 6 and 7 located on left side and linked to sternite 8.

Information on representatives of this monogeneric tribe is given by Hackman & Andersson (1969), Griffiths (1972), and Mathis (1973).

Tribe Chiropteromyzini.

Face concave; postgenal fold absent; fronto-orbital bristles 2, reclinate, the anterior one also sloping outwards; cheek with a horizontal series of bristles; prelabrum rather small; proboscis short, with moderately developed labella; antenna decumbent, with large discoid segment 3; segment 5 cylindrical; propleural bristle well developed; mesopleural bristle absent; one strong sternopleural; dorsocentral bristles 1+3; scutellum without hairs; prosternum elongate, anteriorly narrowed, without precoxal bridges; each tibia with one preapical dorsal bristle and no other bristles but the terminal ones; costa not distinctly weakened just beyond humeral crossvein, with spaced spines between veins 1 and 2 distinguishable but sometimes little differentiated, with section basad of subcostal break having one anterior and one dorsal spine at apex, both little differentiated from seriate setulae; subcosta distally very close to vein 1, but latter terminating distinctly beyond subcostal break of costa; veins 2 and 3 distally diverging; second basal and anal cells short; anal crossvein curved; vein 6 almost straight, not reaching margin; vein 7 short but distinguishable; male postabdomen (Griffiths, 1972) with tergite 6 short but distinct; sternites 6 and 7 located on left side; 2 pairs of surstyli present; aedeagus long and slender; female postabdomen without elongate segments; cerci distinct but rather small.

Frey (1952), Hennig (1971), and Griffiths (1972) provide information on the unique genus of this tribe. Treating it under the name *Chiropteromyza*, these authors overlooked the fact that this was the genus known by the earlier name *Neossos* in North America.

Tribe Cinderellini n.tr.

Fronto-orbital plates indistinct, particularly so anteriorly, with usually 2 pairs of reclinate fronto-orbital bristles, or sometimes a weaker third bristle anteriorly; cheek without prominent central bristle; face entirely sclerotized, with low median tubercle or carina usually not reaching epistomal margin, broadly medially emarginate below, with lower lateral part continuous with hypofacial which is broadly visible below cheek in profile; ptilinal suture arched well above level of antennal sockets, its upper lip not overlapping lower but almost level with it, thus with well exposed and sclerotized lunule; antenna usually slightly decumbent, with subcircular segment 3; arista with minute, rather dense pubescence; prelabrum well developed, deep and rather narrow, its somewhat flattened anterior surface fitting into the broad emargination of lower part of face; proboscis with rather large reflexed labella; propleural bristle usually small and weak; prostigmatal bristle longer; mesopleuron without hairs or bristles; sternopleuron with at least one strong bristle, usually with hairs or incipient bristles anteriorly, but not with anterior elements set higher than posterior bristle; dorsocentral bristles usually 0+2; acrostichal bristles usually represented by the prescutellar pair only; scutellum without hairs (other than pubescence), with lateral pair of bristles rather close to scutellar suture; pleurotergite as in Rhinotorini; prosternum broadly subtriangular, filling area between fore coxae, with well sclerotized precoxal bridges, each of which is traversed by an impressed suture; mid femur with one or more anterior bristles and one preapical posterior bristle; mid tibia with one or 2 preapical dorsal bristles; other tibiae with or without one preapical dorsal bristle; costa slightly weakened just beyond humeral crossvein, with or without spaced anteroventral spines between veins 1 and 2; veins 2 and 3 divergent distally; second basal and anal cells short; vein 6 fading distally, but sometimes extending rather near margin, situated much nearer to posterobasal margin of anal region of wing than to vein 5; vein 7 absent; male postabdomen with tergite 6 reduced, little sclerotized; sternites 6 and 7 laterally placed, the latter joined to sternite 8; spiracles of segment 6 located in membrane; left spiracle 7 located within margin of sternite 7; right spiracle 7 located on a small sclerite near median ventral line; epandrium with pair of basally articulated surstyli; hypandrium without prominent gonites; aedeagus not very complex, rather short (*Cinderella lampra* Steyskal and *C. macalpinei* Hennig: see Steyskal, 1969; Hennig, 1969), or long, slender and strap-like (*C. steyskali* Hennig; author's observations); cerci separate, rather small; female postabdomen with tergites and sternites separate, but those behind segment 7 largely desclerotized; cerci slender, separate; spermathacae 3, 2 of them sharing a common duct (Steyskal, 1969; Hennig, 1969).

This tribe includes only the genus *Cinderella*, but the 8 known species (2 still undescribed) show a range of morphological variation which might have justified earlier workers in dividing the group into several genera. *Cinderella hirsuta* Hennig differs from other species in possessing 5, instead of 2 or 3, pairs of dorsocentral bristles, and otherwise has the bristling of the thorax and abdomen better developed; but, as pointed out by Hennig (1969), it is closely related to *C. steyskali* Hennig and the general hypertrophy of the chaetaxy is probably a recently acquired character. There is some diversity in postabdominal characters. *Cinderella steyskali* has large, conspicuous postabdominal spiracles with pigmented rims, but in *C. lampra* Steyskal they are apparently small, if present at all, as Steyskal (1969) was unable to locate them. On the other hand, they are present in *C. macalpinei* Hennig according to Hennig (1969). *Cinderella lampra* and *C. macalpinei* have the aedeagus short and compact, while *C. steyskali* has a very elongate, strap-like aedeagus. Postabdominal characters are not recorded for the other species.

My studies suggest that the genus is divisible into 3 natural (? monophyletic) groups.

Key to Species Groups of *Cinderella*

1. Costa with spaced anteroventral spines between veins 1 and 2; haltere pale yellowish.....Group 1

——Costa without such differentiated spines; haltere brown.....2

2. Mid tibia with 2 approximated preapical dorsal bristles; head, thorax, and abdomen shining black, scarcely pruinescent.....Group 2

——Mid tibia with 1 preapical dorsal bristle; most of body pruinescent and little shining.....Group 3

Group 1 includes *C. steyskali* Hennig, and *C. hirsuta* Hennig. Group 2 includes *C. lampra* Steyskal, *C. aczeli* Steyskal, and *C. macalpinei* Hennig. Group 3 includes 2 undescribed species from Chile (CNC).

Tribe Epistomyiini n.tr

Fronto-orbital plate of moderate length, with 2 subequal bristles inclined backwards and outwards; antenna decumbent; arista with numerous short hairs; prelabrum large and prominently projecting anteriorly; propleural bristle large; mesopleural bristle absent; sternopleural bristles several, decreasing in size anteriorly; dorsocentral bristles 1+4; acrostichal bristles, including some anterior ones, well developed; scutellum not haired, with one sub-basal and one apical

pair of bristles; pleurotergite somewhat like that of Allophylopsini and Cnemospathini, but with deeper groove more completely separating the two convexities; mid femur with series of anterior bristles distally and a large, isolated subapical posterior bristle; mid tibia with one strong preapical dorsal bristle and strong apical bristles as follows: one anterodorsal, one posterodorsal, 2 ventral; fore and hind tibiae each with one preapical dorsal bristle; costa with spaced anteroventral spines beyond end of vein 1, not very noticeably weakened just beyond humeral crossvein; subcosta not weakened distally, reaching costa but in contact with dilated distal part of vein 1; veins 2 and 3 subparallel distally; vein 6 long, with slight curvature, discontinued a very short distance from margin; vein 7 absent; male postabdomen with sternite 5 bearing pair of prominent horn-like lobes; tergite 6 reduced; sternites 6 and 7 well developed, laterally placed; spiracles of segments 6 and 7 present in membrane; epandrium with one pair of articulated surstyli; aedeagus short and broad; cerci separate, broad; female postabdomen with terminal segments elongate, folding telescopically; cerci somewhat elongate, separate.

Epistomyia has much in common with *Prosopantrum* (Cnemospathini) including many features of chaetotaxy. I have considered placing them in the one tribe but the two genera do not appear to share any distinctive apomorphic characters. Further, it seems possible that *Epistomyia* is as closely related to *Notomyza* (which has a similar pleurotergite), and perhaps to other groups, as it is to *Prosopantrum*. *Prosopantrum*, on the other hand, is perhaps more closely related to the Allophylopsini than to *Epistomyia* on the basis of the pleurotergite and vein 6.

Epistomyia also differs from *Prosopantrum* in the enlarged prelabrum, 5 pairs of dorsocentral bristles, stronger propleural bristle, the progressive shortening anteriorly of the sternopleural bristles, differentiated costal spines, the presence of a pair of processes on male sternite 5, and the short, broad aedeagus.

Tribe Cnemospathini

Fronto-orbital plate of moderate length, usually with 2 bristles inclined outwards and backwards; antenna decumbent; arista with numerous short hairs; propleural bristle small; mesopleural bristle absent; 2 sternopleurals present; dorsocentral bristles usually 0+3 or 0+4; some rather well developed acrostichal bristles often present in front of the prescutellar pair; scutellum not haired, with one sub-basal and one apical pair of bristles; pleurotergite as in Allophylopsini; mid femur armed as in Allophylopsini; mid tibia with 2 or 3 strong dorsal bristles on distal part, including one just before apex and one at about apical third; costa without spaced spines, visibly weakened just beyond humeral crossvein; subcosta distally weakened and close to vein 1; vein 6 as in Allophylopsini; vein 7 absent; male postabdomen with sternite 5 simple, sternites 6 and 7 situated on left side; aedeagus elongate, strap-like; female postabdomen with separate cerci.

The possible sister-group relationship with the Allophylopsini is mentioned below. There are, however, some similarities between Notomyzini and Cnemospathini (notably in the armature of the basal part of the costa), which might seem to negate such a sister-group relationship.

Tribe Allophylopsini

Fronto-orbital plate rather long or moderate, often somewhat separated from eye-margin anteriorly, with 2 reclinate bristles which are sometimes sloped outwards; antenna somewhat decumbent; arista sub-basal on segment 3, varying from extensively short-haired to long-plumose; propleural bristle minute; mesopleural bristle absent; usually one sternopleural bristle present; dorsocentral bristles 0+3, 1+2, or 1+3; scutellum with 2 pairs of major bristles one of which is sub-basal; pleurotergite of distinctive structure (see above); mid femur with a series of anterior bristles distally and a large, isolated apical to subapical posterior bristle; mid tibia with 2 large, approximated dorsal bristles beyond middle, and no other bristles but the terminal ones; costa distinctly weakened just beyond humeral crossvein, usually with visible but rather short spaced spines; subcosta either distally weakened and approximated to vein 1, or well developed and distally diverging from vein 1 (*Leriopsis*); vein 6 abruptly discontinued well before margin, its distal end often slightly curving towards posterior margin; vein 7 absent; male postabdomen (Tonnoir & Malloch, 1927; McAlpine 1967; Griffiths, 1972) with tergite 6 free, sternites 6 and 7 laterally placed; spiracle of segment 7 absent; female postabdomen with separate cerci, with spiracle of segment 7 absent so far as known (McAlpine, 1967).

The apomorphic features of the pleurotergite appear to indicate that the Allophylopsini and Cnemospathini are sister groups. Further evidence of relationship between these tribes is provided by the extent and contour of vein 6, the break or weak point in the costa just beyond the humeral crossvein, which is more distinct than in most heleomyzids, and the pair of slightly enlarged spines at the distal end of the succeeding costal section next to the subcostal break.

A key to the genera of this tribe is given by McAlpine (1967).

Tribe Borboroidini n.tr

Fronto-orbital plate of moderate length with one strong posterior bristle, which is reclinate and variably sloped outwards, and an anterior one, that may be directed outwards or forwards, or is much reduced; antenna porrect or slightly decumbent; arista inserted sub-basally on segment 3, with numerous very short hairs; proboscis with well developed labella; propleural bristle vestigial or absent; mesopleural bristle absent; sternopleural bristles usually 2, very unequal; at most 3 dorsocentral bristles; scutellum not haired, with one

sub-basal and one apical pair of bristles; prosternum rather short and broad, usually subtriangular, without precoxal bridges; mid tibia with pair of approximated preapical dorsal bristles and one to 3 anterior bristles near middle, or (in *Heleomicra*) all these bristles absent; costa not spinose; subcosta distally distinct and slightly diverging from vein 1, or distally obsolete and somewhat approximated to vein 1; veins 2 and 3 forking well before level of base of discal cell; anal cell angular posterodistally, often obtusely so; anal crossvein nearly straight; vein 6 not reaching margin; vein 7 absent; male postabdomen with tergite 6 reduced (*Heleomicra*) or absent (*Borboroides*); sternites 6 to 8 united into a single large sclerite; cerci separate in both sexes.

There is an element of doubt regarding the degree of relationship between the 2 included genera, *Borboroides* and *Heleomicra*. Although their type-species are superficially very similar insects, there are some important differences and the shared apomorphic characters do not form a very distinctive set.

Tribe Notomyzini

Face somewhat concave, with slightly raised median line; postgenal fold absent; fronto-orbital bristles 2, curved outwards, in addition the anterior one somewhat proclinate, the posterior one somewhat reclinate; no outstanding central cheek bristle present; other cheek bristles not entirely seriate; prelabrum moderately developed; proboscis rather short, with labella of moderate size; antenna almost porrect; distal surface of segment 2 not markedly oblique; segment 3 discoid; arista densely short-haired throughout; segment 5 somewhat swollen; propleural bristle minute; mesopleural bristle absent; one strong sternopleural bristle present; dorsocentral bristles 0+3; acrostichal bristles absent, or a weak prescutellar pair present; scutellum without hairs; prosternum without precoxal bridges; pleurotergite intermediate between allophylopsine and rhinotorine types; each tibia with one preapical dorsal bristle, and no other bristles but the terminal ones; costa weakened beyond humeral crossvein, without spaced spines; subcosta distally obsolete; veins 2 and 3 slightly converging distally; second basal and anal cells of moderate length; anal crossvein somewhat curved and recurrent; vein 6 rather short and abruptly discontinued; vein 7 absent; male postabdomen (Malloch, 1933; Griffiths, 1972; author's observations) with remarkably large, setulose tergite 6; sternites 6 to 8 absent and the protandrium symmetrical (Griffiths, 1972), or of these only sternite 6 present, linear and asymmetrically placed; surstylus basally articulated; aedeagus forming a short tube; cerci fused below anus or small and more or less separate; female with simple, separate cerci.

Notomyza, the only included genus of this tribe, has been assigned an isolated position in a monogeneric family of doubtful relationship by Griffiths, 1972, but, except for peculiarities of the male postabdomen, it is not remarkably different from some other south-temperate heleomyzids. There are remarkably few constant characters for separation of *Notomyza* from *Prosopantrum* (Cnemospathini), even the bristling of the mid tibia being the same as in some species of *Prosopantrum*. The resemblance of *Notomyza* to *Borboroides* is also close, the pleurotergite being quite similar in both.

Griffiths describes the male postabdomen of *Notomyza* as 'fully symmetrical', on the basis of material of *N. edwardsi* Malloch. My material of an unidentified species of *Notomyza* from Vicuña, Tierra del Fuego, (AM) (Fig. 83) has an asymmetrically placed sternite (6 or 6+7). The absence of sternite 8 and the large tergite 6 appear to be constant characters of the genus.

Tribe Gephyromyzini n.tr.

Face almost flat or slightly prominent along median line; vertical postgenal fold absent; fronto-orbital bristles 3, somewhat reclinate, the anterior one slightly incurved; central cheek bristle absent; prelabrum not prominent; labella moderately developed; antenna porrect or almost so; arista inserted near base of segment 3; segment 5 rather large; propleural bristle vestigial; mesopleural bristle absent; sternopleural bristles usually 2, unequal; dorsocentral bristles 0+3, 1+3, or 1+4; scutellum without hairs; prosternum rather small, without precoxal bridges; each tibia with one preapical dorsal bristle and no other bristles but the terminal ones; costa with prominent spaced spines between terminations of veins 1 and 2; subcosta complete or almost so, distally approximated to vein 1; vein 2 long, distally diverging from vein 3; anal crossvein much curved; vein 6 variable in length; vein 7 absent; male postabdomen (author's observations) with tergite 6 much reduced; sternites 6 and 7 laterally displaced, well sclerotized; sternite 8 large; postabdomen of female variable (Hennig, 1969); segment 6 with free tergite and sternite; cerci often free.

This principally neotropical tribe is well defined but it is difficult to determine its relationship to other tribes. I provisionally accept the limits of the genera as given by Malloch (1933) and Hennig (1969), but a detailed morphological study might result in a realignment of the species. The number of sternopleural bristles, used by Malloch as a distinguishing character between *Gephyromyza* and *Cephodapedon*, has proved too variable with the discovery of additional species of the latter genus, and the difference in the length of vein 6 is not great.

The aedeagus is variable in size and structure in this tribe, and its diversity is perhaps a product of the speciation process, as in *Diplogeomyza*. In *Cephodapedon nigriventer* Hennig, the aedeagus is quite long and slender, in *C. fulvicorne* Malloch it is stouter and distally expanded (Hennig, 1969), in *Gephyromyza penicillipes* Malloch it is small and slender with

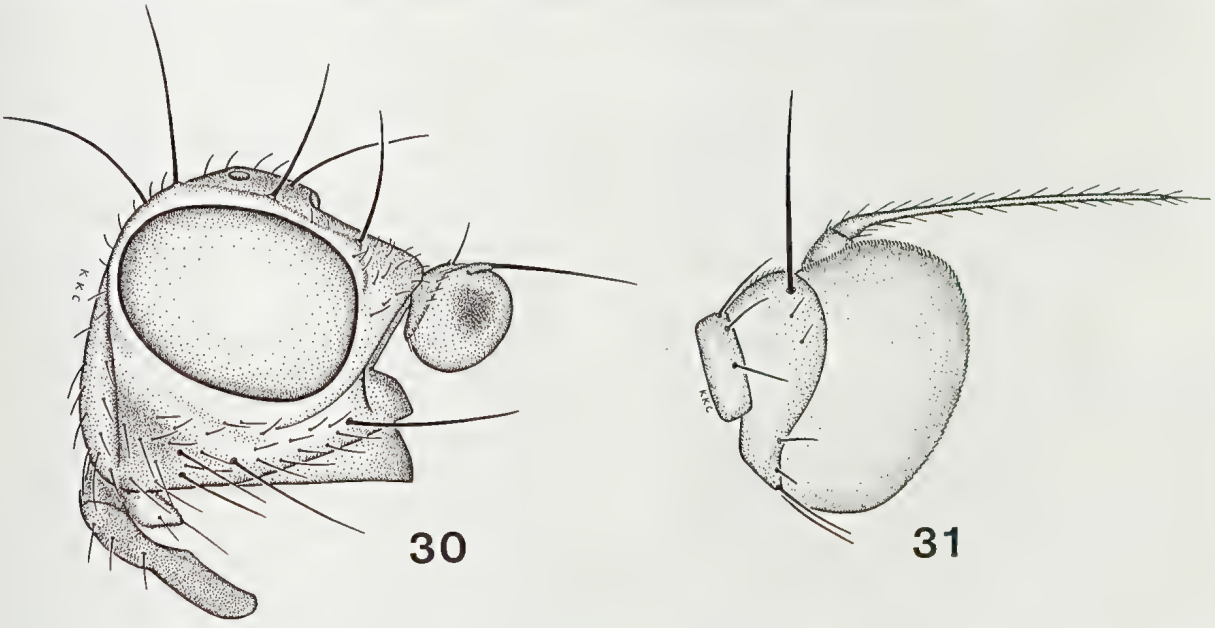
attenuated sclerotized apical section, and in *Paraneossos arizonicus* Wheeler it forms a short, simple tube (my observations). The arrangement of the protandrial sclerites, on the other hand, is fairly uniform in the tribe, so far as it has been investigated.

The genus *Paraneossos*, described by Wheeler (1955) from Arizona, U.S.A., is here recorded from South America for the first time on the basis of material from Calamarca Province, Argentina, and Malleco Province, Chile, in CNC. These specimens are specifically distinct from but closely related to *P. arizonicus* Wheeler. *Paraneossos* differs from *Gephyromyza* in its smaller size (wing length under 3 mm in the former, over 4 mm in the latter), in the lesser curvature of the basal part of vein 2, and in the smaller palpus; it differs from *Cephodapedon* in having only three dorsocentral bristles, though one available Chilean specimen, otherwise agreeing with *Paraneossos*, has five unequal dorsocentral pairs. Also *Paraneossos* has a characteristic band of dense, pale pubescence-pruinescence across the lower margin of the face, laterally passing above the vibrissa and along the orbital margins of the cheek and postgena. Species of the other two genera do not have such a well defined zone of thick pruinescence.

Tribe Nephellini n.tr.

Fronto-orbital plate extending over most of length of postfrons, approximated to eye margin, bearing 2 reclinate bristles; sockets of ocellar bristles situated behind anterior ocellus and about as far apart as the posterior pair of ocelli; cheek with strong bristle a little below middle; postgenal fold very deeply incised; face broad, entirely sclerotized, with short median carina above, convexly prominent at epistomal margin on entire width; ptilinal suture laterally terminating behind vibrissa, where it curves posteriorly; antenna porrect, with segment 3 subcircular; arista rather short and stout, minutely densely haired, inserted slightly before middle of segment 3, with segment 5 relatively large and segment 6 a little thickened basally; prelabrum large and prominent; palpus very short; proboscis with labella much reduced; propleural bristle long; prostigmatal bristle absent; mesopleuron and sternopleuron bare, except for 2 sternopleural bristles; dorsocentral bristles 1+4; acrostichal bristles scarcely differentiated; anterior notopleural bristle reduced; scutellum moderately short, with 2 pairs of bristles and few hairs; prosternum narrow-oblong; fore femur with dorsal and posteroventral bristles; tibiae without bristles; costa a little weakened just beyond humeral crossvein, with pair of spines terminating section proximal to subcostal break, on succeeding section with slightly differentiated spines among the hairs of the posteroventral series; subcosta almost complete, distally very close to vein 1; veins 2 and 3 slightly convergent distally; vein 6 discontinued well away from margin; vein 7 absent; male postabdomen: protandrium behind segment 6 strongly dorsoventrally compressed; tergite 6 and sternite 6 fused into an attenuated transverse band, which is broadly discontinuous on right side; a spiracle (apparently of segment 6) situated on each side behind this band; sternite 7 apparently absent; sternite 8 large and rounded; genital segment compact, deflexed; epandrium with one pair of basally articulated surstyli; aedeagus short, simple, symmetrical, flanked on each side by an equally long gonite; cerci fused into a triangular structure, joined on each side to a small convex sclerite at each posteroventral angle of epandrium; female postabdomen with free, rather elongate cerci.

The monotypic temperate South American genus comprising this tribe has some features suggesting relationship to the Rhinotorini, viz. the porrect antenna



Figs 30–31. *Nephellum dendrophilum* (Malloch). **30**, head. **31**, left antenna (medial aspect).

with the arista inserted not very close to the base of segment 3, the reduced palpus, the absence of the preapical tibial bristles, and the fusion of the cerci. Except for the first character, these are, within the Rhinotorini, marked trends rather than ground-plan characters, and in the greater number of dorsocentral bristles *Nephellum* is perhaps more plesiomorphic than the Rhinotorini. In most characters of chaetotaxy (other than reduction of the preapical tibial bristles), *Nephellum* agrees with the tribe *Pentachaetini*, but it differs in the abovementioned points of resemblance to the Rhinotorini; in the greater number of sternopleural bristles; in the different relative sizes of the two notopleural bristles; and in the more reduced protandrium. The deeply impressed postgenal fold is unique among heleomyzids; in the Rhinotorini and Pentachaetini there is no visible postgenal fold. In Malloch's figure 45, illustrating the head of *N. dendrophilum*, the postgenal fold is clearly shown, but the head was somewhat collapsed and the details of the antenna are not accurate. My figures 30, 31 correct these points.

Nephellum dendrophilum (Malloch) is apparently uncommon, as the type-material is all that has been available to me. Like certain rhinotorines, it has been found on exudations on tree trunks.

Tribe Rhinotorini

Vertex of head more or less excavated (scarcely so in *Zentula* and in some species of *Anastomyza* and *Apophoneura*); face uniformly sclerotized, usually clitelliform or with transverse furrow near middle, often with epistomal margin prominent; cheek rather broad, with strong bristle near centre (except in *Zentula* and *Cairnsimyia*); hypofacial usually extensively visible in lateral aspect below cheek; fronto-orbital bristles reclinate, 2 present or anterior one variably reduced; prelabrum generally large, often prominent; proboscis somewhat elongate with small labella; antenna more or less porrect, with segment 3 usually subcircular to horizontally ovoid; arista inserted near or beyond middle of dorsal surface of segment 3, with minute pubescence or sometimes almost glabrous; propleural bristle variably developed, often vestigial; mesopleural bristle absent (except in *Cairnsimyia cavifrons* Malloch); sternopleural bristles usually 2 or more; dorsocentral bristles 0+3 to 0+1; prosternum rather narrow, without precoxal bridges; preapical dorsal tibial bristles often weak or absent; hind femur with one isolated preapical dorsal bristle in American forms other than *Anastomyza*; costa often somewhat weakened just beyond humeral crossvein, with spaced spines in some primitive South American forms only; anal crossvein curved; vein 6 discontinued well before margin, straight or slightly curved backwards distally; vein 7 absent; male postabdomen (McAlpine, 1968; Griffiths, 1972) with tergite 6 variably reduced, often fused with sternite 8; sternite 6 and 7 placed on left side, often joined to sternite 8; sometimes (*Rhinotora*, *Neorhinotora*, *Apophoneura*) segment 6 with a complete ventral band of secondary sclerotization; postabdomen of female simple, with cerci of variable length, sometimes joined to proctiger for part of their length.

I previously (McAlpine, 1968) gave reasons for considering *Anastomyza* and *Apophoneura* to be related to the Rhinotorini but defined the tribe so as to exclude them. I now feel that these genera should be included in the Rhinotorini.

Griffiths (1972) considers it probable that *Cairnsimyia* is less closely related to *Rhinotora* and its immediate allies than are *Anastomyza* and *Apophoneura* – in other words the neotropical rhinotorines together form a monophyletic group. While this is a possibility, one would then have to assume that the more extreme modifications of the head capsule and the loss of the spaced costal spines evolved independently in Australia and South America. In both the Australian and Neotropical Region there are southern forms with simple, possibly plesiomorphic head structure (e.g. *Zentula vittata* n.sp. and *Anastomyza fractura* Malloch, 1933, Fig. 46), and northern tropical forms with apparently highly apomorphic head structure (e.g. *Cairnsimyia aroana* McAlpine and *Neorhinotora* species). On the other hand, no Australian rhinotorine is known with well developed spaced costal spines like those of *Anastomyza* and *Apophoneura* species. The absence of the postvertical bristles is characteristic of the American *Rhinotora* and *Neorhinotora* and some Australian *Cairnsimyia* species, the rest of the tribe having normal convergent postverticals. Probably the isolated central cheek bristle, the long vein 2 apically converging with vein 3, and the supernumerary crossveins in the marginal cell are groundplan characters for the whole neotropical rhinotorine stock, but these characters do not occur in Australian representatives of the tribe. On the other hand, there is a strong general resemblance between *Rhinotoroides* and certain *Cairnsimyia* species which may not be entirely convergent, and the possibility should not be overlooked that *Anastomyza* represents the sister group to the rest of the tribe. An interesting, apparently apomorphic character of the genus *Anastomyza*, not found in any other genus of the tribe, is the thickening of the costa immediately before its junction with the subcosta, and the particularly deep incision of the costa next to the thickening (Fig. 26).

Adult rhinotorines have been found at exudations on tree trunks in Australia, New Guinea, and South America. They may be very cryptically coloured in this habitat.

Three clearly monophyletic groupings in the tribe Rhinotorini are defined as follows:

Subtribe 1 (*Cairnsimyia*, *Zentula*, Australian Region). Cheek bristle absent; presutural bristle absent or minute; dorsocentral bristles one, or 2 closely placed; scutellum setulose; propleuron centrally haired or not; hind femur with or without short series of preapical dorsal to anterodorsal bristles; spaced costal spines absent or scarcely differentiated; costal break at end of subcosta

simple; male postabdomen: sternite 5 not bilobed; sclerites of segment 6 widely discontinuous on right side; surstylus movably articulated at base.

Subtribe 2 (*Anastomyza*, southern Neotropical Region). Cheek bristle present; presutural bristle present; dorsocentral bristles three; scutellum not setulose; propleuron with fine hairs (in addition to pruinescence); preapical anterodorsal bristle of hind femur absent, or short and almost terminal; spaced costal spines distinct; costa thickened on basal side of break, which is deeply incised; male postabdomen: sternite 5 bilobed (except in *Anastomyza discalis* Malloch); tergite 6 distinct and separate; sclerites of segment 6 widely discontinuous on right side; surstylus immovably fused with epandrium.

Subtribe 3 (*Apophoneura*, *Rhinotoroides*, *Rhinotora*, *Neorhinotora*, Neotropical Region). Cheek bristle present; presutural bristle present; dorsocentral bristles 2, well separated; scutellum without setulae; propleuron without hairs except at lower extremity; hind femur with one strong anterodorsal bristle at about apical fifth; spaced costal spines absent (except in *Apophoneura*); costal break simple; male postabdomen: sternite 5 deeply bilobed; tergite 6 never present as a separate sclerite; sclerites of segment 6 encircling abdomen without a break, except sometimes in mid-dorsal region where parts are fused with sternite 8 (condition unrecorded in *Rhinotoroides*); surstylus movably articulated at base (rather rigidly so in *Rhinotoroides*).

Tribe Pentachaetini n.tr.

Fronto-orbital plate extending most of length of postfrons, approximated to eye margin, bearing 2 reclinate bristles; sockets of ocellar bristles situated behind anterior ocellus and rather close together; cheek strongly bristled near middle, without postgenal fold; face evenly sclerotized, concave or almost flat; ptilinal suture laterally terminating well behind vibrissa (*Pentachaeta*), or directly above it (*Dioche*); antennal segment 3 markedly decumbent, oval; arista inserted sub-basally on segment 3, with segment 5 very short and segment 6 scarcely thickened basally; prelabrum moderately developed, rather prominent; palpus rather long; proboscis moderately short, with well developed labella; propleural bristle present or absent; prostigmatal bristle minute or absent; mesopleuron and pteropleuron bare; sternopleural bristles one or 2; notopleural bristles long, the anterior one larger; dorsocentral bristles 1 + 4 or, in *Dioche*, 1 + 3, all long; acrostichal bristles absent; scutellum of moderate size with 2 pairs of bristles, otherwise bare or with very few hairs; prosternum short and narrow; fore femur with long dorsal and posteroventral bristles; each tibia with one preapical dorsal bristle only; costa broken only at end of subcosta (*Pentachaeta*), or also visibly weakened just beyond humeral crossvein (*Dioche*), without spaced spines; subcosta rather distinct distally, diverging a little from vein 1 (*Pentachaeta*) or apically fusing with vein 1 (*Dioche*); veins 2 and 3 distally parallel or convergent; vein 6 rather abruptly discontinued well away from margin; vein 7 absent; male postabdomen with tergite 6 not greatly reduced, but little sclerotized and pigmented; sternites 6 and 7 laterally placed, distinct in *Dioche*, not separately identifiable in *Pentachaeta*, in either case sclerotically linked to sternite 8; spiracles of segments 6 and 7 located in pleural membrane; epandrium with one pair of basally articulated surstyli; hypandrium with one or 2 pairs of gonites posteriorly; aedeagus with stout capsular distiphallus and smaller basiphallus, the latter with large unpigmented posterior process; aedeagal apodeme complex, its distal (posterior) part continuous with basiphallus, its anterior part elbowed and connected to anterior part of hypandrium; cerci separate.

Tribe Trixoscelidini

Fronto-orbital plate approximated to eye-margin, long, extending in front of middle of postfrons, with two strong bristles, both reclinate or the anterior one incurved, or fronto-orbital bristles absent; ocellar bristles either situated one on each side of anterior ocellus, or approximated within ocellar triangle; central cheek bristle sometimes present; antenna more or less decumbent; segment 3 oval; arista inserted sub-basally on segment 3; proboscis with labella well developed or somewhat reduced; prosternum small, oval; propleural bristle moderate to small; mesopleuron with several setulae, often upwardly directed, and one or 2 strong posterior bristles (the latter absent in *Paratrixoscelis*); sternopleural bristles usually 2, with some associated setulae; dorsocentral bristles generally 2 + 3; scutellum not haired, with one lateral sub-basal and one subapical pair of bristles; tibiae each with one or 2 pairs of preapical dorsal bristles rather close to apex; mid femur usually with anterior bristles and one preapical posterior bristle; costa deeply incised at end of subcosta, without visible weakening just beyond humeral crossvein, with pair of bristles or spines terminating section before subcosta, and with spaced spines of variable length between subcosta and vein 2; subcosta distally touching the expanded distal part of vein 1 (not distinctly so in *Psiloplagia*); veins 2 and 3 distally diverging; anal crossvein curved, making an obtuse angle with vein 6; vein 6 sclerotized and pigmented basally, distally reduced to a crease in membrane not reaching margin; vein 7 absent; male postabdomen (in *Trixoscelis*) with tergite 6 much reduced, free; sternites 6 and 7 located on left side and joined to the dorsal sternite 8; spiracles of segment 6 located in membrane, those of segment 7 apparently absent; epandrium with posteriorly located articulated surstylus (the 'anterior surstylus' of Cogan, 1971, may be a gonite); aedeagus variable (Hackman, 1970), without differentiated sclerotized basiphallus, usually elongate, partly membranous, often lobed distally, with variable longitudinal pigmented strips; cerci reduced, often fused; female postabdominal segments, so far as known, all short; segment 7 with tergite and sternite fused (*Trixoscelis*, *Stuckenbergiella*)

and without spiracle (*Trixoscelis*: Hennig, 1958).

Melander (1952) divided the true trixoscelidines known to him into three genera, viz. *Trixoscelis*, *Spilochroa*, and *Zagonia*. The two latter are defined on the basis of coloration, representing the most and the least pigmented species respectively, with little if any constant morphological difference from *Trixoscelis* s. str. I doubt if these groupings form a natural classification on a world basis, and I include *Spilochroa* and *Zagonia* in synonymy of *Trixoscelis*.

Cogan regards the South African genus *Stuckenbergiella* Cogan, 1971, as a member of this tribe, and I concur. Thanks to Dr A. Soós I have been able to examine material of the genera *Paratrixoscelis* (from Mongolia) and *Psiloplagia* (the latter known only from the type-material of *Ps. pachypterna* Czerny, 1928, from Transcaspian U.S.S.R.). These genera clearly also belong in the Trixoscelidini.

There is often sexual dimorphism of the hind tarsus in this tribe. In *Paratrixoscelis* and some species of *Trixoscelis* the hind basitarsus is slightly or markedly thicker in males. In males of *Psiloplagia* the basitarsus of every tarsus is strongly inflated, and the second segment is also modified. In females these segments are quite slender. The male of *Stuckenbergiella* is unknown to me.

There are two probably monophyletic groups in the tribe, which are characterised as follows:

Subtribe 1 (*Trixoscelis*, *Paratrixoscelis*). Ocellar bristles inserted in front of level of anterior ocellus and farther apart than centres of lateral ocelli; segment 6 of arista gradually thickened basally; face not remarkably high and narrow.

Subtribe 2 (*Stuckenbergiella*, *Psiloplagia*). Ocellar bristles inserted behind level of anterior ocellus and less far apart than centres of lateral ocelli; segment 6 of arista with strong basal swelling; face more than twice as high as wide.

Tribe Fenwickiini n.tr.

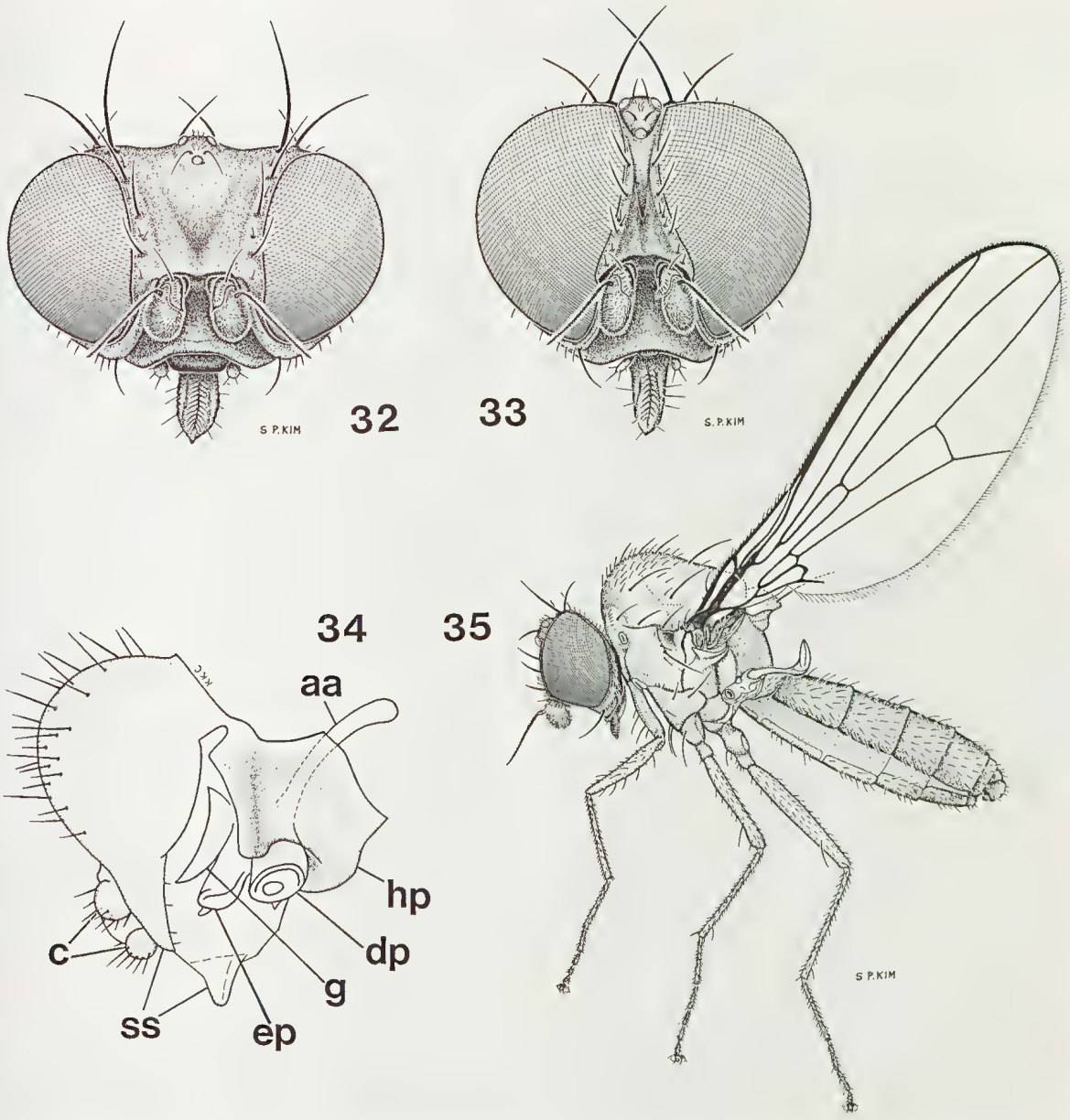
Fronto-orbital plate long, parallel with eye margin, bearing 3 reclinate bristles; cheek without differentiated central bristle; face uniformly sclerotized, with complete submarginal groove; antenna with segment 3 oval, more or less decumbent; arista densely short-haired, with segment 5 subcylindrical; prelabrum prominent; proboscis with well developed labella; propleural bristle present, usually short; mesopleuron with long posterior bristle and short setulae not directed upwards; sternopleural bristles one or 2; dorsocentral bristles 1 + 3 or 0 + 3; scutellum usually without hairs (exception: *Fenwickia hirsuta* Malloch); prothoracic spiracle normal, with filter of hairs within aperture; prosternum narrow, without precoxal bridge; hind femur with preapical anterodorsal bristle and, in male only (as far as known), with strong ventral bristle before middle; each tibia with one preapical dorsal bristle; costa not visibly weakened just beyond humeral crossvein, with section before subcostal break terminated by one strong bristle, preceded by one or 2 long anterodorsal bristles; section of costa between veins 1 and 2 with short, spaced anteroventral spines; subcosta distally not desclerotized but fusing with the apically thickened vein 1; veins 2 and 3 diverging distally; anal crossvein strongly curved; vein 6 short or very short; vein 7 absent; second basal and anal cells short; male postabdomen (examined in detail only in *Fenwickia claripennis* Malloch) almost symmetrical with reduced tergite 6; cerci often large and united with proctiger to form a broad lobe; female postabdomen with all segments short; segment 7 with tergites and sternites united into a complete ring in at least some species; cerci short.

The Fenwickiini resemble the Waterhouseiini in a number of characters, viz. the 3 reclinate fronto-orbitals, the strong mesopleural bristle, and most characters of wing venation. Some species of this tribe even have an indication of the dilation of the anal crossvein at the point of maximum curvature, as in *Waterhouseia*, and geographically the tribes are not remote. On the other hand there are great differences in the male postabdomen between *Waterhouseia* and the only fenwickiine species yet examined in detail, *Fenwickia claripennis*. The tendency towards symmetry of the protandrium is shared by both.

The main features of the postabdomen of *F. claripennis* are as follows (Fig. 96; Harrison, 1959: Fig. 195): tergite 6 reduced to a narrow transverse dorsal strip, only strongly sclerotized along anterior margin, with one or 2 setulae near each lateral extremity; a composite, complete, slightly asymmetrical protandrial ring present behind tergite 6, which, from comparison with *Waterhouseia*, probably includes tergite and sternite 7 and possibly sternite 6; anterior margin of protandrial ring sclerotically thickened on entire circumference; median ventral part of ring well sclerotized and setulose, perhaps representing sternite 6; left lateral part of ring, probably representing sternite 7, also with a few setulae; spiracles of segment 6 in membrane just below each lateral margin of tergite 6; right spiracle 7 in lateral part of protandrial ring; left spiracle 7 apparently absent; sternite 8 large, setulose, joined to protandrial ring at its narrowest median dorsal point; one pair of basally articulated surstyli present; one pair of gonites present; aedeagus long, strap-like, asymmetrical, not differentiated into basiphallus and distiphallus, with pair of longitudinal pigmented strips on basal half, fusing in the more complex distal half; aedeagal apodeme joined before its posterior end, not to hypandrium, but to aedeagus; ejaculatory apodeme of sperm pump rod-like, curved, slightly thickened at anterior end, very obliquely cut off posteriorly; cerci large, forming with the proctiger a ventrally projecting plate.

Tribe Waterhouseiini n.tr

Head sexually dimorphic, with postfrons narrowed in male; fronto-orbital plate very long and



Figs 32–35. *Waterhouseia cyclops* Malloch. **32**, head of female. **33**, head of male. **34**, male genital segment (right lateroventral aspect). **35**, whole insect (male). **aa**, aedeagal apodeme. **c**, cercus. **dp**, distiphallus. **ep**, epiphallus. **g**, gonite. **hp**, hypandrial plate. **ss**, surstylus.

approximated to eye margin, with 3 strong reclinate bristles; cheek narrow, without outstanding central bristle; face uniformly sclerotized, with complete submarginal groove; antenna slightly decumbent, with segment 3 rounded-oval; arista densely short-haired; segment 5 cylindrical; prelabrum prominent; proboscis with rather large labella; propleural bristle small but distinct; mesopleuron with one long posterior bristle and a few downwardly directed setulae; sternopleural bristles 2; dorsocentral bristles 1 + 3 or 1 + 4; scutellum without hairs, with 2 subequal pairs of bristles, one of which is sub-basal; prothoracic spiracle apparently closed or almost so; prosternum short, oblong, bare, without precoxal bridges; tibiae without preapical bristles; costa not weakened just beyond humeral crossvein, without spaced spines; subcosta complete though slightly weakened on a short preterminal section, close to vein 1 throughout; veins 2 and 3 diverging distally; anal crossvein strongly reflexed, dilated at bend; vein 6 short; vein 7 absent; second basal and anal cells short; abdomen slender, subcylindrical; male postabdomen with segment 6 symmetrical, its tergite and sternite well developed and setulose; surstylus imperfectly articulated at base; aedeagus short, stoutly cylindrical, with stout posterior process flanked by the paired gonites; cerci short, well separated; female postabdomen simple, having all segments short, with separate tergites and sternites; cercus short.

This is an Australian tribe of a single known species. It may be related to the Fenwickiini of New Zealand (q.v. for comparison).

Tribe Mayomyiini n.tr.

Fronto-orbital plate of moderate length, with 3 short bristles sloped backwards and outwards; cheek without prominent central bristle; face desclerotized except for narrow lateral plates against parafacial sutures and small sclerotized area between antennal sockets; antenna decumbent, with segment 2 deeply notched dorsally on distal margin, segment 3 very large and leaf-like; arista with segments 4 and 5 remarkably long; labella of proboscis rather small; propleural bristle present or absent; mesopleural bristle present; one sternopleural bristle present; dorsocentral bristles 0+2; acrostichal bristles absent; scutellum with 2 pairs of bristles and no hairs; pleurotergite as in Rhinotorini; prosternum short, without precoxal bridges; mid femur with usually one anterior bristle near middle and, in males only, a well developed, somewhat oblique series of posterior bristles, but no outstanding subapical posterior bristle; hind femur with one or 2 preapical dorsal bristles; mid tibia usually with short preapical dorsal bristle; costa without spaced spines, broken only at end of subcosta but not very distinctly so; subcosta distally merging with the dilated vein 1; veins 2 and 3 slightly convergent distally; vein 4 strongly curved forward distally to meet vein 3 at its termination in costa; vein 6 short; vein 7 unpigmented, distinguishable only as a curved fold in membrane; wing membrane with zone of minute, crowded microtrichia on distal side of anal crossvein; male postabdomen with tergite 6 reduced to a narrow strip; sternite 6 reduced, laterally placed, its upper end just below left lateral extremity of tergite 6; sternite 7 laterodorsally placed, not fused to sternite 8; spiracles of segment 6 situated near each end of tergite 6; left spiracle 7 situated near upper end of sternite 7, a little to the right of median dorsal line; right spiracle 7 not found in the single preparation, perhaps absent; epandrium with one pair of broad, basally articulated surstyli; hypandrium with one pair of slender, rod-like gonites and, in *Mayomyia nigripalpis* Malloch only, a long median posterior process; aedeagus moderately stout, short to moderately long, almost symmetrical, little sclerotized; cerci separate, of moderate size, or, in *M. nigripalpis*, very large; female postabdominal segments not very elongate, segments 6 and 7 with separate tergites and sternites; cerci separate, rather slender.

The only included genus, *Mayomyia*, appears to have no close allies. Though it resembles Heleomyzini and certain Diaciini in the desclerotized median part of the face, I can find no other evidence of relationship to those tribes. *Mayomyia* resembles the tribes Fenwickiini and Waterhouseiini in having 3 pairs of reclinate fronto-orbital bristles in combination with a strong mesopleural bristle, and further approaches Waterhouseiini in reduction of the preapical dorsal tibial bristles. The protandrium and face are quite different in these groups, while the apical confluence of veins 3 and 4 distinguishes *Mayomyia* from all other known heleomyzids.

Geographic Distribution.

The Heleomyzidae are essentially a temperate climate group, though of limited representation in the tropics.

Apart from the fact that southern Africa has been occupied only by tribes of northern origin (presuming *Stuckenbergiella* to be a trixoscelidine and *Prosopantrum* to be introduced by man), the tribes fall clearly into either north- or south-temperate categories. Outside the African Region, probably no tribe in the one category has speciated in the opposite temperate zone. Though more species have been described from the north-temperate zone than the south-temperate, the number of tribes belonging to the former zone is less than half that of the latter. The north-temperate tribes are: Heleomyzini, Borboropsini, Suilliini, Chiropteromyzini, and Trixoscelidini. Though these tribes differ in regional representation, none is to be classed as either principally palearctic or nearctic.

By contrast, the south-temperate heleomyzid groups show a more complex distribution pattern, which is no doubt due to the more prolonged isolation of the southern land-masses from each other. I class the southern tribes thus:

Australian tribes: Tapeigastrini, Borboroidini, Waterhouseini.

New Zealand tribe: Fenwickiini.

Tribe common to Australia and New Zealand: Allophylopsini.

South American tribes: Zachaetomyiini, Blaesochaetophorini, Cinderellini, Epistomyiini, Cnemospathini, Notomyzini, Gephyromyzini, Nephellini, Mayomyiini.

Tribes common to Australia and South America: Diaciini, Rhinotorini, Pentachaetini.

I note that where tribes are common to more than one southern area, the genera in the different areas are all distinct.

It has become usual to regard taxa with restricted south-temperate distributions as being Gondwanaland relicts. However some characteristic southern groups (e.g. Sciadoceridae and Ironomyiidae) have been found as fossils in the north-temperate zone, and there is a possibility that numerous other groups presently with a southern distribution may have formerly occurred in the northern hemisphere. In the absence of fossil heleomyzids in the southern hemisphere, and their meagre representation in collections from the northern hemisphere, we have no evidence as to whether southern heleomyzid groups are of Gondwanaland origin, or whether they are relict groups formerly of wider distribution. From the available fossil evidence, the radiation of the Schizophora appears not to have begun till the early tertiary when Gondwanaland had started to disintegrate. There remains the possibility that the component continents, except perhaps Africa, were still

close enough to allow some interchange of fauna. That the initial differentiation of heleomyzid groups was quite early is demonstrated by the presence in Baltic amber (Eocene–Oligocene) of forms possibly referable to the tribes Heleomyzini and Suilliini (Hennig, 1965).

The limited tropical representation of the Heleomyzidae is interesting, because the tropical zone seems often to have been a major barrier to dispersal, even, to some extent, in Africa. Representatives of the Rhinotorini are successful in tropical lowlands both in Australia–New Guinea and the Americas, in the latter area crossing the tropics to the southern U.S.A. In New Guinea they are the only known heleomyzids. The genus *Cinderella* (tribe Cinderellini) is distributed from Tierra del Fuego to the United States but the tropical records refer to localities at and above 2000 m elevation in Ecuador (Hennig, 1969). The Gephyromyzini are another essentially South American group represented by one species in the United States. The few heleomyzids in the tropics of the Oriental Region are derivatives of the north-temperate fauna and perhaps occur mainly at higher altitudes (tribes Suilliini and Heleomyzini). They have no relationship to the heleomyzids of the Australian Region.

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Appendix 1.
A New Neotropical Genus and Species.

Dioche n.gen.

Type-species. *D. khooi* n.sp.

Description. Flies resembling *Pentachaeta* in many characters, but lacking the characteristic thoracic and wing markings of that genus. Thorax and abdomen thinly pruinescent and somewhat shining.

Head: postrons with fine scattered hairs but no anterior marginal bristles; cheek with most setulae near lower margin short and not seriate; lower occipital bristle shorter than in *Pentachaeta*; palpus a little shorter than in *Pentachaeta*.

Thorax: propleural bristle absent; dorsocentral bristles 4; scutellum with very few fine hairs (3 in available specimen); chaetotaxy otherwise as in *Pentachaeta*. Tibiae of male not swollen. Second basal and anal cells very small for the family, each about 0.1 of length of discal cell.

Abdomen: protandrium rather similar to that of *Pentachaeta*, but with sternite 7 distinct, laterally placed, narrowly joined to sternites 6 and 8; details of genital segment generally as given for *Pentachaeta*; hypandrium with one pair of short posterior gonites; distal capsule of aedeagus less complex than in *Pentachaeta*.

Further characters are as given under the tribe Pentachaetini.

Discussion. *Dioche* differs from other South American heleomyzid genera with a strong central cheek bristle in having four pairs of dorsocentral bristles and very small anal and second basal cells. The large, decumbent antennal segment 3 with arista inserted close to its base further distinguishes it from the rhinotorine genera, while the presence of one strong preapical dorsal bristle on each tibia and the absence of an impressed postgenal fold distinguish it from *Nephellum*. It differs from *Trixoscelis* in the more approximated ocellar bristles, the absence of the mesopleural bristle and spaced costal spines, and in the longer vein 2. *Dioche* is apparently most closely related to the Australian genus *Pentachaeta*, from which it differs in the number of dorsocentral bristles (4 instead of 5), the absence of the propleural bristle, and the absence of the distinctive markings on the wing and thorax of the latter genus.

Dioche has a superficial resemblance to species of the family Pseudopomyzidae (see Hennig, 1969). It differs from these in having the arista inserted sub-basally on antennal segment 3, the face uniformly sclerotized, the two pairs of scutellar bristles subequal, one strong preapical dorsal bristle on each tibia, and quite different male postabdomen.

Etymology. The generic name is derived from the Greek διοχη, distance, in reference to its geographic remoteness from the other genus of the tribe Pentachaetini. It is feminine.

Dioche khooi n.sp.

Figs 36–39,62,94

Description (male). *Coloration*: generally tawny-brown with brown-black bristles and hairs; possibly darker in fresh material. Head tawny, with brown zone surrounding ocelli; face paler. Antenna with segments 1 and 2 pale yellowish, segment 3 tawny. Palpus and proboscis pale fulvous. Legs pale tawny; fore femur predominantly brown; tarsi slightly browned distally. Wing faintly yellowish, without markings. Haltere tawny, with creamy capitellum.

Postabdomen: surstylus broadly oblong.

Dimensions: total length 3.4 mm; length of thorax 1.4 mm; length of wing 4.3 mm.

Distribution. Chile – Valdivia Province.

HOLOTYPE ♂ (unique). Pucatrihue, 40°28'S, 73°47'W, 12 iii 1965 (CNC), L.E. Peña.

Appendix 2.
Key to Neotropical Genera of Heleomyzidae

1. Fronto-orbital bristles 3, reclinate.....2

——Fronto-orbital bristles 1 or 2.....5

2. Face desclerotized medially; vein 4 curved forward to meet vein 3 near wing apex..... *Mayomyia*

——Face uniformly sclerotized; veins 3 and 4 widely separated apically.....3

3. More than 3 pairs of dorsocentral bristles present.....*Cephodapedon*

——Only 3 pairs of dorsocentral bristles present.....4.

4. Wing over 4 mm long; vein 2 with sigmoid curvature in basal half. .....*Gephyromyza*

——Wing under 3 mm long; vein 2 almost straight.....*Paraneossos*

5. Face desclerotized except on pair of deep, rounded subantennal pits; major scutellar bristles less than half as long as scutellum; wing membrane blackish, without pattern.....*Dichromya*

——Face not as above; scutellar bristles longer; wing not thus pigmented.....6

6. Face divided into 3 panels, the median one little sclerotized, the lateral ones strongly so; subcosta strongly developed and diverging from vein 1 distally; vein 6 extending faintly to margin.....7.

——Face uniformly sclerotized; if vein 6 extending approximately to margin, then subcosta not markedly diverging from vein 1.....8

7. Pteropleuron bristled; mid tibia with only the preapical bristle; scutellum not setulose.....*Pseudoleria*

——Pteropleuron bare; mid tibia with 2 anterodorsal and 1 posterodorsal bristle in addition to preapical bristle; scutellum setulose.....*Aecothea*

8. Mesopleural bristle present; sockets of ocellar bristles placed well apart and level with anterior ocellus.....*Trixoscelis*

——Mesopleural bristle absent (scattered setulae sometimes present); sockets of ocellar bristle at least slightly behind anterior ocellus.....9

9. Fronto-orbital plate short, sloping away from eye margin anteriorly, and bearing one bristle only; costa with strong, spaced spines; vein 1 terminating far beyond subcosta.....*Suillia*

——Fronto-orbital plate parallel with eye or bearing more than 1 bristle; other characters variable.....10

10. Vein 6 curved forwards so that its unpigmented distal extremity is subparallel with vein 5.....11

——Vein 6 not thus curved.....12

11. Face deeply concave; 1 distinct sternopleural bristle present; prosternum without precoxal bridges.....*Diacia*

——Face not concave; 2 or more sternopleural bristles present; prosternum with distinct precoxal bridges.....*Blaesochaetophora*

12. Hind tibia with strong dorsal bristles near and before middle; lateral scutellar bristles situated behind middle of length of scutellum; size large, wing over 6 mm long.....*Zachaetomyia*

——Hind tibia with, at most, only the preapical dorsal bristle; lateral scutellar bristles situated before middle of length of scutellum; size often smaller.....13

13. 1 strong central cheek bristle present above level of lower marginal hairs of cheek.....14

——Central cheek bristle absent.....20

14. Dorsocentral bristles 4 or 5.....15

——Dorsocentral bristles 2 or 3.....16

15. Dorsocentral bristles 5; postgenal fold forming a deep groove; preapical dorsal tibial bristles absent ..... *Nephellum*

——Dorsocentral bristles 4; postgenal fold absent; each tibia with one preapical dorsal bristle ..... *Dioche*

16. Dorsocentral bristles 3; costa much thickened on proximal side of break at end of subcosta ..... *Anastomyza*

——Dorsocentral bristles 2; costa not thus thickened 17

17. Postvertical bristles absent; vertex of head deeply excavated; scutellum much modified 18

——Postvertical bristles present; vertex less deeply or not excavated; scutellum not modified 19

18. Scutellum with marked median dorsal channel, without apical median tubercle; face with convexity on each side near vibrissa; eye, in profile, rounded oval ..... *Neorhinotora*

——Scutellum without dorsal channel, with apical median tubercle; face without pair of convexities; eye, in profile, narrowly oblique ..... *Rhinotora*

19. Costa with spaced anteroventral spines beyond end of subcosta; supernumerary crossveins in marginal cell simple or absent; fore femur without short ventral spines ..... *Apophoneura*

——Costa without spaced spines; supernumerary crossveins in marginal cell branched; fore femur with numerous short ventral spines near middle. ..... *Rhinotoroides*

20. Hypofacial broadly visible below cheek in profile; fronto-orbital bristles reclinate; prosternum with sclerotized precoxal bridges ..... *Cinderella*

——Hypofacial vestigial, scarcely visible in profile; at least anterior fronto-orbital bristle directed outwards; precoxal bridges absent 21

21. Dorsocentral bristles 5, subequal; vein 6 long, extending almost to margin. ..... *Epistomyia*

——Dorsocentral bristles fewer than 5, or the anterior ones vestigial; vein 6 short. 2

22. Postfrons with coarse proclinate setulae near middle anteriorly; at least 2 strong sternopleural bristles present ..... *Prosopantrum*

——Postfrons with proclinate setulae absent or very minute; only 1 strong sternopleural bristle present ..... *Notomyza*

Appendix 3.
Partial Key to Palearctic Genera of Heleomyzidae

1. Vein 6 discontinued before reaching wing margin 2

——Vein 6 continued to margin though faint distally 6

2. Fronto-orbital bristles absent; vein 1 terminating near middle of length of wing (at 0.46 – 0.48 of length of wing from its base) ..... *Psiloplagia*

——Fronto-orbital bristles present; vein 1 terminating well before middle of wing 3

3. Mesopleural bristle long; fronto-orbital bristles 2, both reclinate ..... *Trixoscelis*

——Mesopleural bristle absent or undifferentiated; fronto-orbital bristles variable. 4

4. Only 1 fronto-orbital bristle present, the fronto-orbital plate bearing it sloping away from eye-margin anteriorly; subcosta and vein 1 distally divergent. ..... *Suillia*

——2 fronto-orbital bristles present, both close to eye-margin; subcosta and vein 1 not distally divergent.....5

5. Dorsocentral bristles in 4 pairs; antennal segment 3 subcircular.....*Neossos*

——Dorsocentral bristles in 5 pairs; antennal segment 3 oval, longer than wide ..... *Paratrixoscelis*

6. Face uniformly sclerotized, with prominent lower margin; mesopleural bristle long.....*Borboropsis*

——Face with median stripe desclerotized or little sclerotized; mesopleural bristle usually absent, if present small.....Other genera (tribe Heleomyzini)

I omit the numerous genera of the tribe Heleomyzini from this key as I have not made a detailed comparative study of them. They are included in the keys given by Czerny (1924; 1927a), Séguy (1934), Collin (1943), and Gorodkov (1970). It should be noted that, in the work of Collin, the name *Helomyza* is applied to the genus otherwise known to modern workers as *Suillia*.

Appendix 4.
List of New Names, Synonymy, and Combinations.

(1) Heleomyzidae.

New tribal names: Diaciini, Blaesochaetophorini, Zachaetomyiini, Cinderellini, Epistomyiini, Borboroidini, Gephyromyzini, Nephellini, Pentachaetini, Fenwickiini, Waterhouseiini, Mayomyiini.

New tribal status: Borboropsini, Chiropteromyzini, Cnemospathini, Notomyzini.

New generic names: *Ollix*, *Amphidysis*, *Heleomicra*, *Zentula*, *Pentachaeta*, *Dioche*, *Nephellum* (replacement name for *Nephoneura* Malloch, 1933).

New generic synonymy: *Dihoplopyga* Malloch, 1933 = *Blaesochaetophora* Czerny, 1904.

New specific names: *Ollix cogani*, *Amphidysis hesperia*, *Heleomicra collessi*, *Zentula vittata*, *Pentachaeta physopus* (the above species all from Australia), *Dioche khooi* (Chile).

New combinations: *Nephellum dendrophilum* (Malloch) (*Nephoneura*), *Blaesochaetophora norma* (Malloch) (*Dihoplopyga*), *Blaesochaetophora polita* (Malloch) (*Dihoplopyga*).

Nomen dubium: *Helomyza marginalis* Walker, 1858 – probably not a heleomyzid.

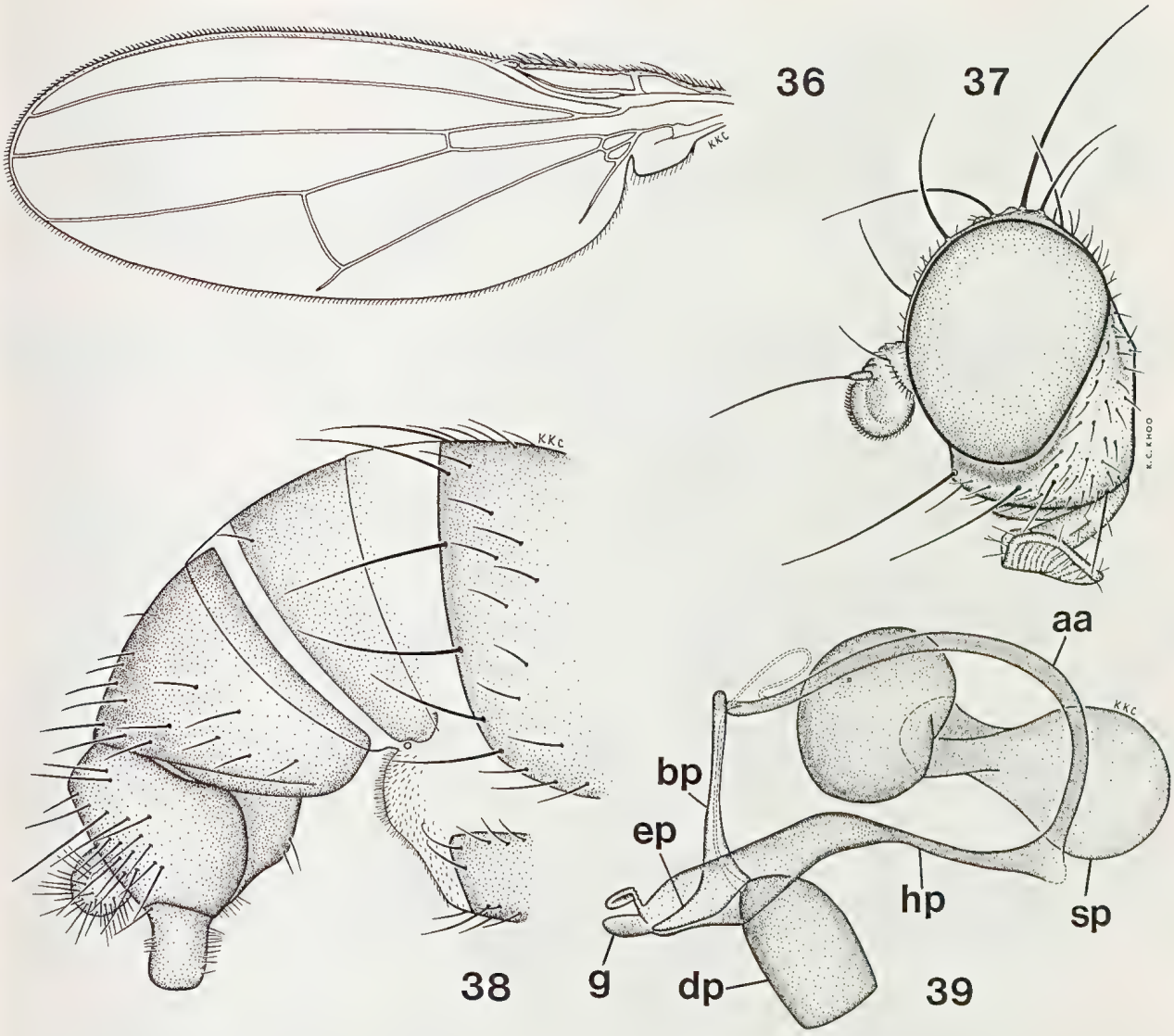
(2) Lauxaniidae.

New combinations: *Meiosimyza lineata* (Walker) (*Sciomyza*), *Sapromyza rufifrons* (Walker) (*Helomyza*).

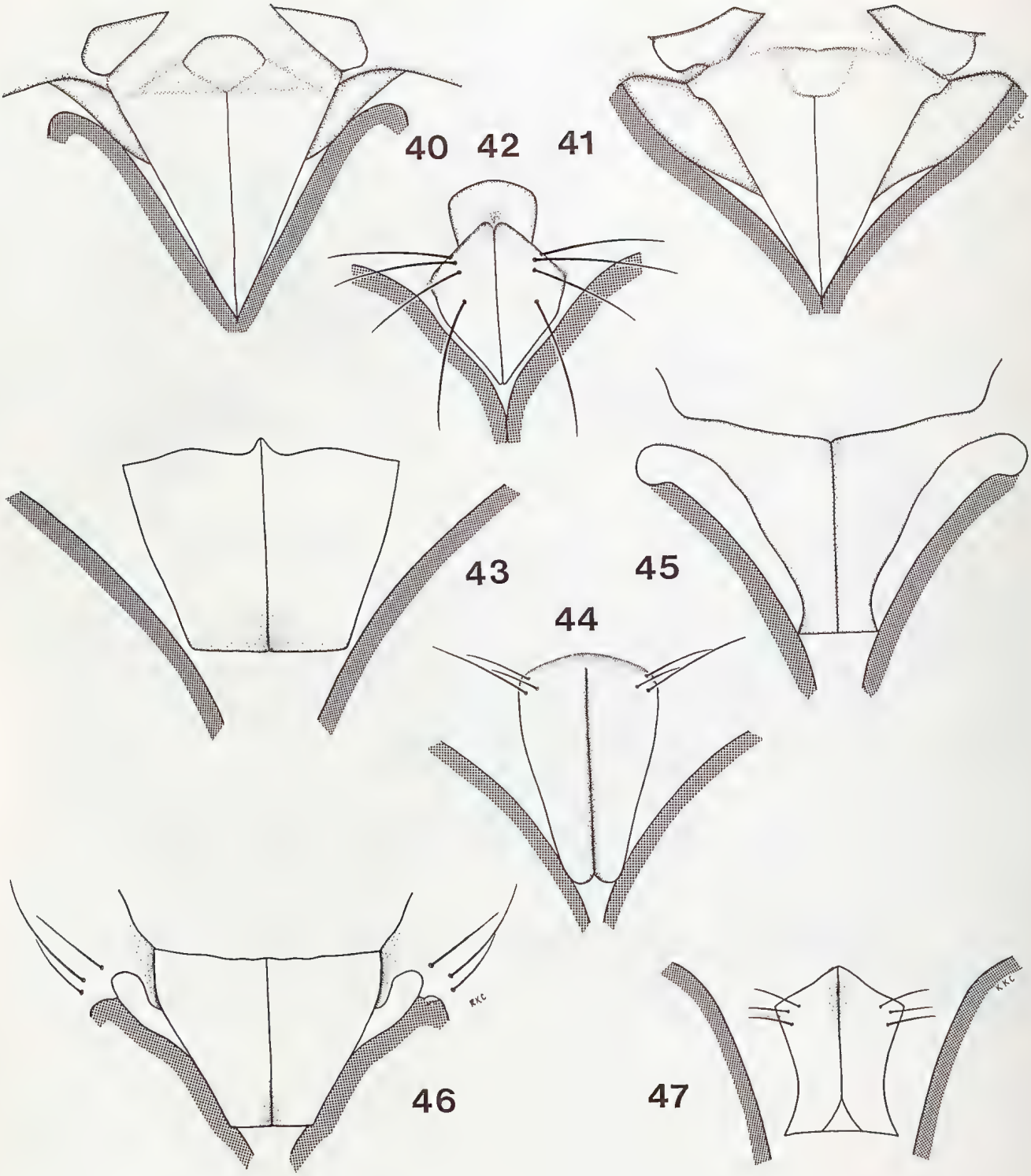
New specific synonymy: *Sapromyza bicoloripes* Malloch 1926a = *Meiosimyza lineata* (Walker, 1853), *Helomyza pallida* Walker, 1853 (not *H. pallida* Fallén, 1820) = *Sapromyza rufifrons* (Walker, 1853).

(3) Helcomyzidae.

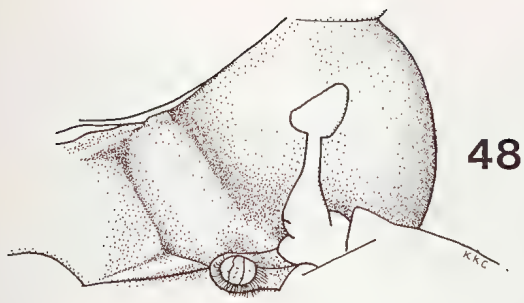
New combination: *Helcomyza vittata* (Macquart) (*Helomyza*) – status in genus and locality doubtful.

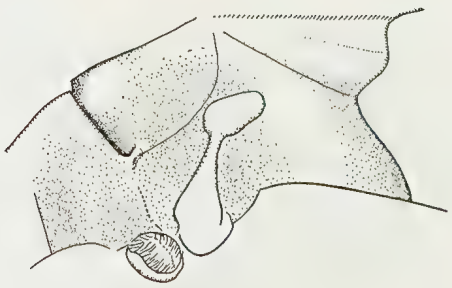


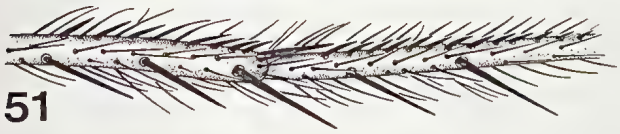
Figs 36–39. *Dioche khooi* n.sp. **36**, wing. **37**, head. **38**, male postabdomen from segment 5. **39**, hypandrium with aedeagus (right lateral aspect). **aa**, aedeagal apodeme. **bp**, basiphallus. **dp**, distiphallus. **ep**, epiphallus. **g**, gonite. **hp**, hypandrium. **sp**, sperm pump.



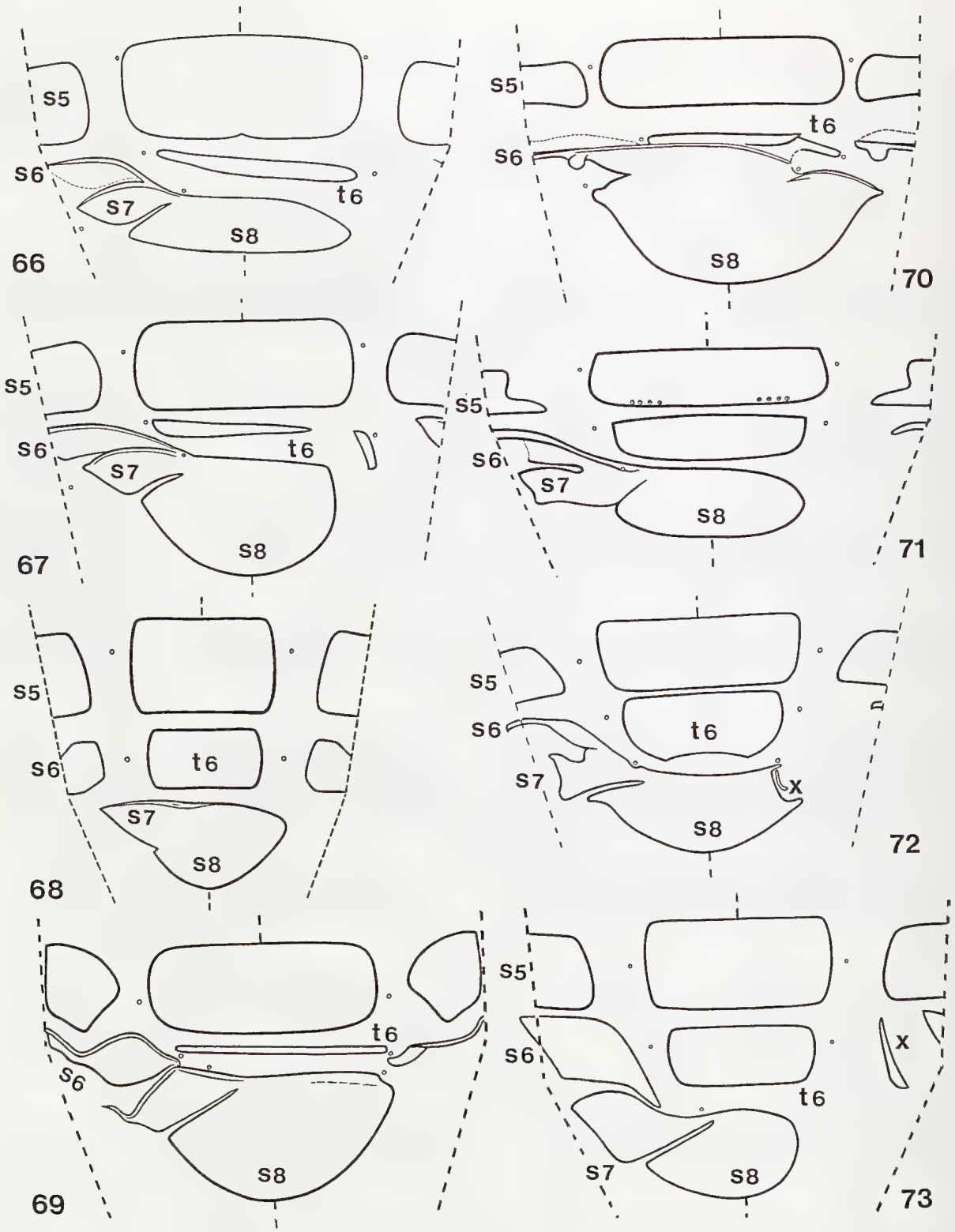
Figs 40–47. Prosterna of heleomyzid flies (margins of fore coxae stippled). **40**, *Pseudoleria placata* (Hutton). **41**, *Tephrochlamys rufiventris* (Meigen). **42**, *Amphidysis hesperia* n.sp. **43**, *Dichromya sanguiniceps* (Wiedemann). **44**, *Suillia* sp. **45**, *Blaesochaetophora* sp. **46**, *Cinderella steyskali* Hennig. **47**, *Mayomyia diversipennis* Malloch.



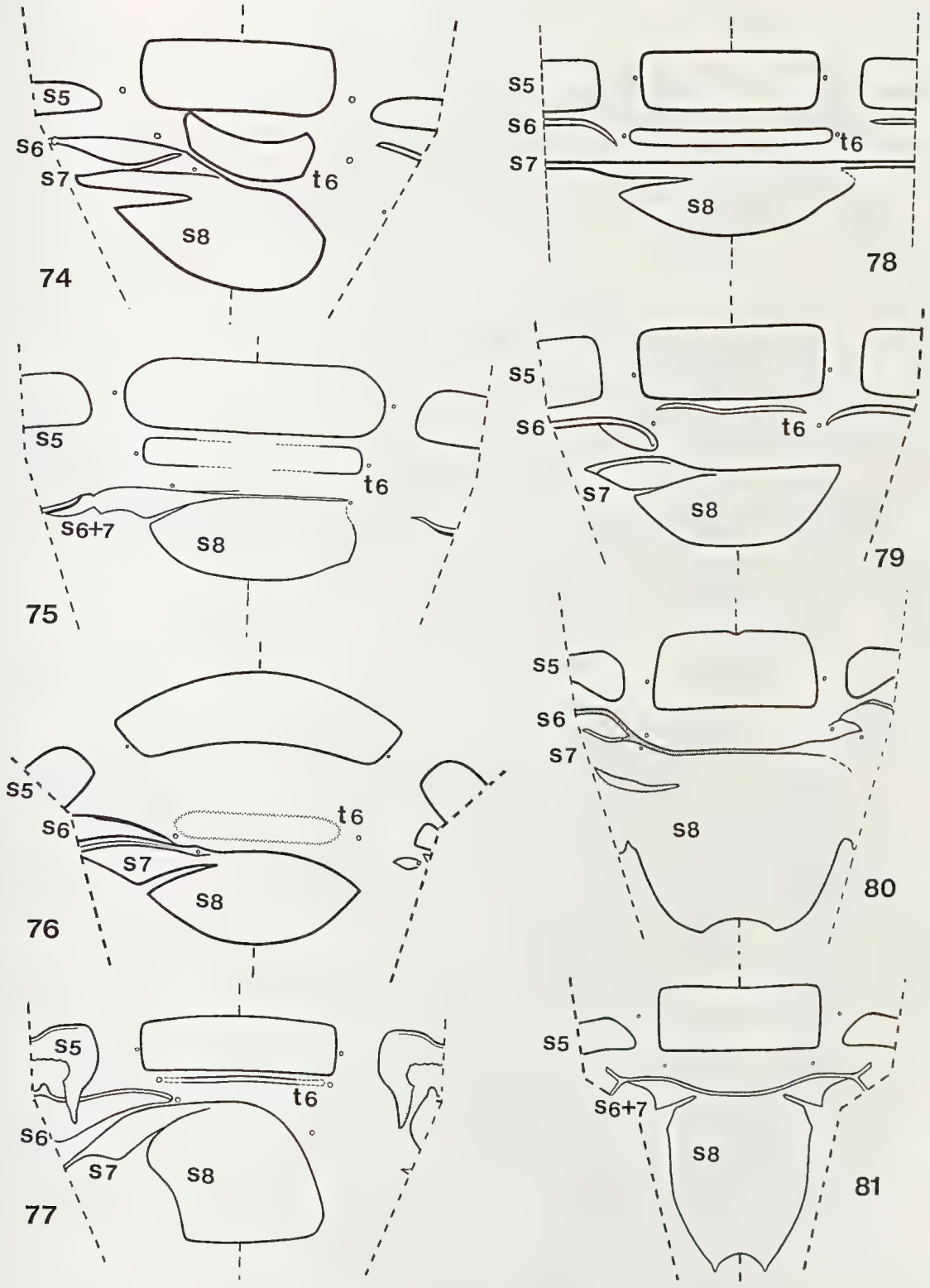




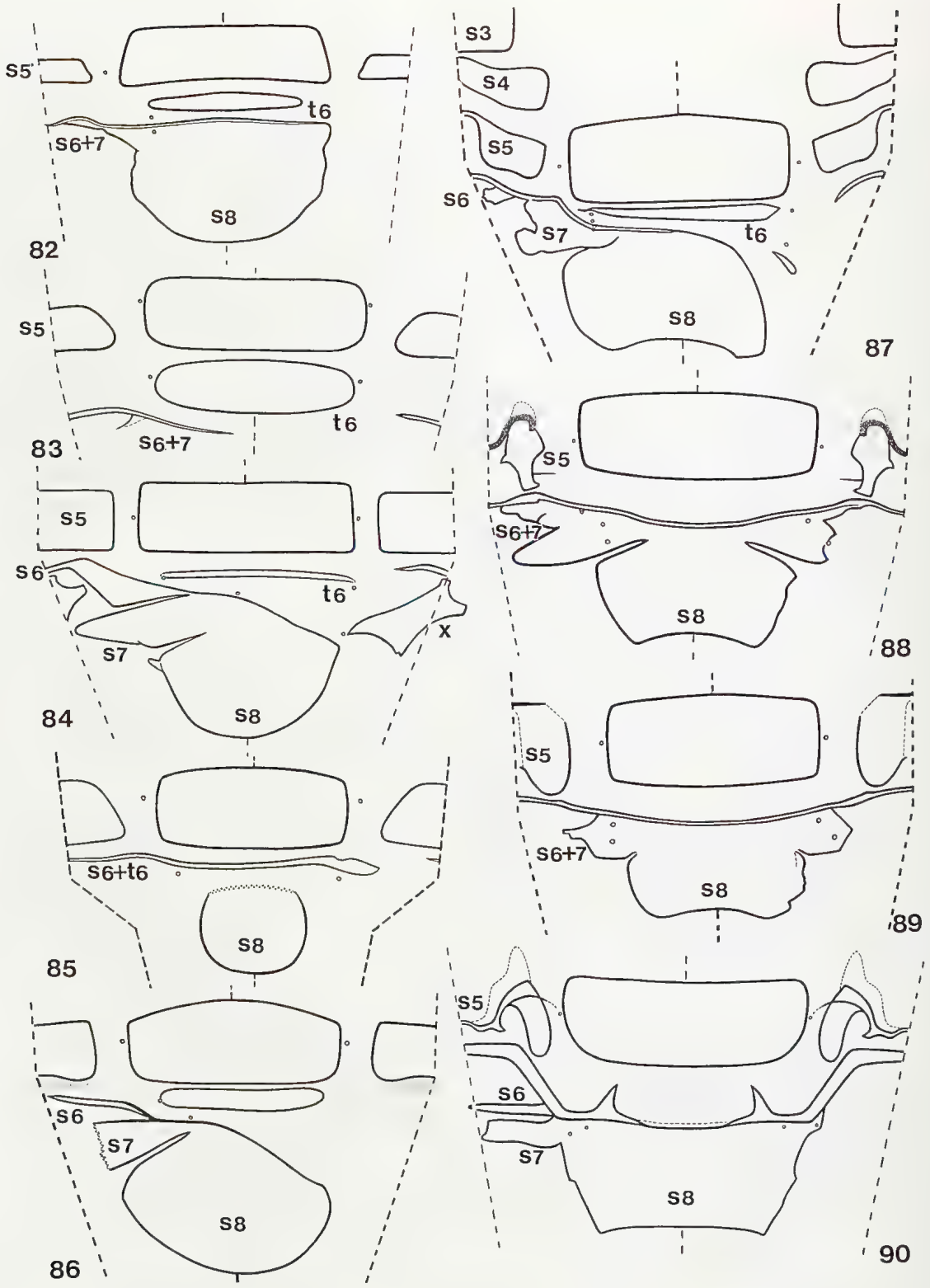
Figs 48–65. 48, region of pleurotergite of thorax of *Tapeigaster annulipes* Macquart to show rhinotorine structure. **49,** the same of *Diplogeomyza spinosa* McAlpine to show allophylopsine structure. **Figs 50–65.** Part of costa near termination of subcosta (anterior aspect) of left wing. **50,** *Heleomyza serrata* (Linné). **51,** *Scoliocentra villosa* (Meigen). **52,** *Heteromyza rotundicornis* (Zetterstedt). **53,** *Diacia diadema* (Wiedemann). **54,** *Zachaetomyia atriventris* Malloch. **55,** *Austroleria truncata* McAlpine. **56,** *Borboroides* sp. **57,** *Nephellum dendrophilum* (Malloch). **58,** *Anastomyza hyalipennis* Malloch. **59,** *Rhinotoroides bifurcata* Lopes. **60,** *Cairnsimyia* sp. (Mooney Mooney Creek, N.S.W., AM). **61,** *Pentachaeta physopus* n.sp. **62,** *Dioche khooi* n.sp. **63,** *Trixoscelis ornata* (Johnson). **64,** *Fenwickia hirsuta* Malloch. **65,** *Xeneura picata* (Hutton).



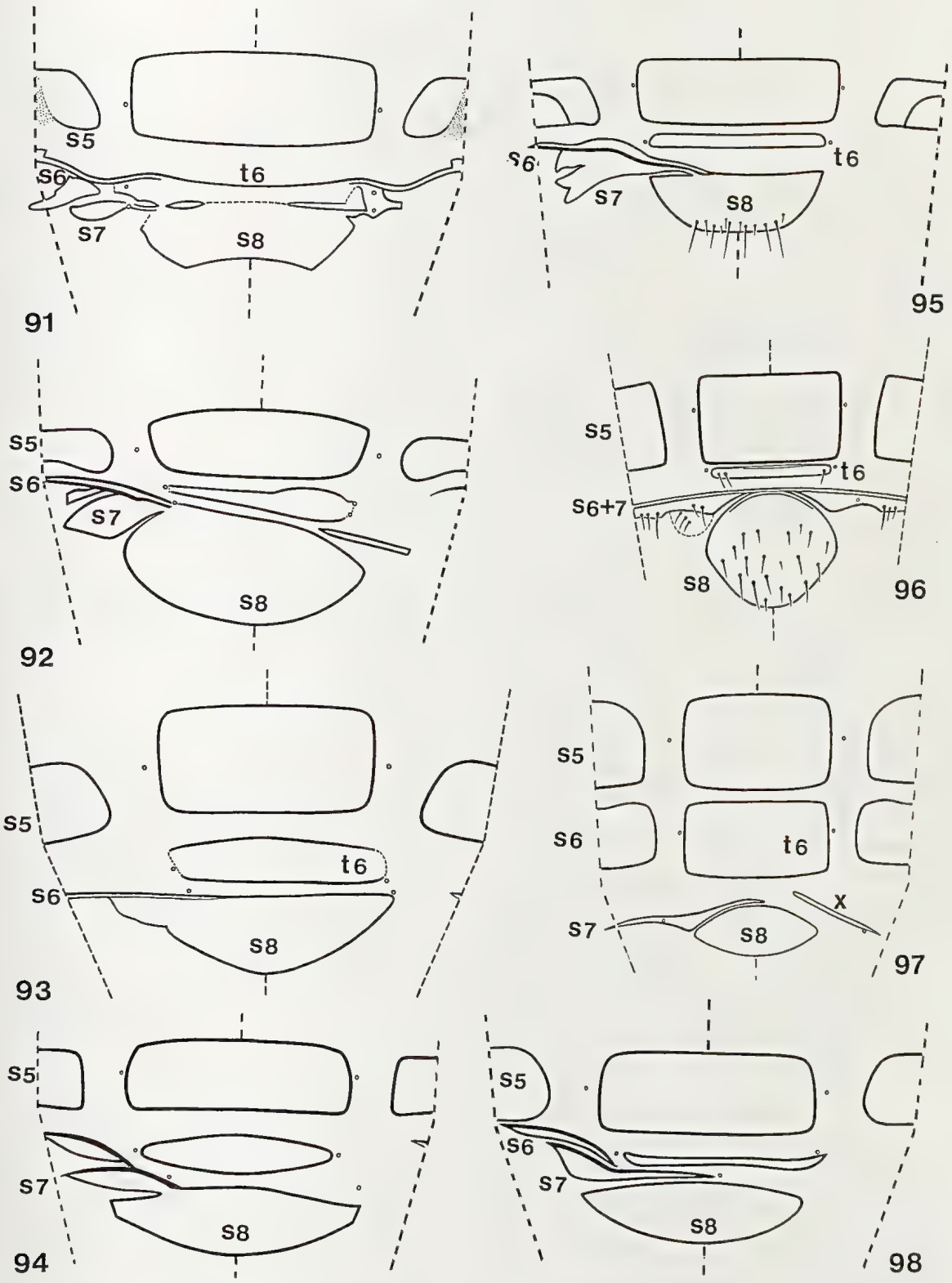
Figs 66–73. Protandrograms of Heleomyzidae. **66**, *Pseudoleria pectinata* Loew. **67**, *Scoliocentra villosa* (Meigen). **68**, *Heteromyza rotundicornis* (Zetterstedt). **69**, *Tapeigaster annulata* (Hendel). **70**, *Suillia ustulata* (Meigen). **71**, *Diacia diadema* (Wiedemann). **72**, *Dichromya sanguiniceps* (Wiedemann). **73**, *Amphidysis hesperia* n.sp. **s5–s8**, sternites 5–8. **t6**, tergite 6. **x**, supernumary or unidentified sclerite.



Figs 74–81. Protandrograms of Heleomyzidae. **74**, *Zachaetomyia atriventris* Malloch. **75**, *Blaesochaetophora picticornis* Bigot. **76**, *Cinderella steyskali* Hennig. **77**, *Epistomyia aurifrons* Malloch. **78**, *Austroleria truncata* McAlpine. **79**, *Allophylopsis inconspicua* Tonnoir and Malloch. **80**, *Borboroides* sp. (Mount Wilson, N.S.W., AM). **81**, *Borboroides atra* Malloch.



Figs 82–90. Protandrograms of Heleomyzidae. **82,** *Heleomicra* sp. (Tasmania, ANIC). **83,** *Notomyza* sp. (Tierra del Fuego, CNC). **84,** *Gephyromyza penicillipes* (Enderlein). **85,** *Nephellum dendrophilum* (Malloch). **86,** *Anastomyza discalis* Malloch. **87,** *Anastomyza* sp.A (CNC). **88,** *Apophoneura* sp. B (CNC). **89,** *Apophoneura* sp. A (CNC). **90,** *Rhinotora pluricellata* Schiner.



Figs 91–98. Protandrograms of Heleomyzidae. **91**, *Neorhinotora mutica* (Schiner). **92**, *Cairnsimyia uniseta* McAlpine. **93**, *Pentachaeta* sp. B (AM). **94**, *Dioche khooi* n.sp. **95**, *Trixoscelis ornata* (Johnson). **96**, *Fenwickia claripennis* Malloch. **97**, *Waterhouseia cyclops* Malloch. **98**, *Mayomyia diversipennis* Malloch.

Index to supraspecific taxa

Acantholeria 220
Acrostichalia 220
Aecothea 205, 206, 215, 220, 224, 240
Allophyla 220, 225
Allophylina 205, 220
Allophylopsini 216, 218, 220, 223 226, 229, 236
Allophylopsis 205, 220, 247
Amoebaleria 220
Amphidysis 205, 207, 208, 209, 215, 218, 219 220, 225, 226, 242, 244, 246
Anastomyza 216, 217, 220, 232 233, 241, 245, 248
Aneuria 204, 220
Anorostoma 220, 224
Anthomyzoinea 220
Anymphochaeta 220
Anypotacta 220
Apetaenus 216, 220
Apophoneura 216, 220, 232 233, 241, 248
Asteioidea 218
Austroleria 206, 209, 210, 215 220, 224, 245, 247
Blaesochaetophora 218, 220, 227, 240 242, 244, 247
Blaesochaetophorini 220, 222, 226 227, 236, 242
Blephariptera 206, 220
Blepharopterina 220
Borboridae 210
Borboroides 205, 210, 215, 218, 220 224, 230, 245, 247
Borboroidini 220, 223, 229, 236, 242
Borboropsidae 203
Borboropsini 216, 220, 221, 227, 236, 242
Borboropsis 220, 242
Cairnsimyia 205, 212, 215, 220 232, 245, 249
Canace 227
Canacidae 227
Cephodapedon 216, 220, 230, 231, 240
Chaetomus 220
Chiropteromyza 216, 219, 220, 228
Chiropteromyzidae 203, 220, 221
Chiropteromyzini 220, 223, 227, 236, 242
Chloropidae 218
Chyromyidae 216
Cinderella 217, 218, 220, 228 237, 241, 244, 247
Cinderellini 220, 222, 228, 236, 237, 242
Clusiidae 218
Cnemospathidae 203, 220, 221
Cnemospathini 216, 218, 220, 221, 223 229, 230, 236, 242
Cnemospathis 208, 215, 220
Desertoleria 220, 224
Diacia 207, 217, 219, 220, 225 226, 240, 245, 246
Diaciini 207, 217, 218, 220, 221, 222 225, 226, 227, 236, 242
Diastata 220
Dichromya . 208, 218, 219, 220, 226, 240, 244, 246
Dihoplopyga 220, 227, 242
Dioche 220, 233, 239, 241, 242, 243, 245, 249
Diplogeomyza 206, 210, 215, 219 220, 224, 230, 245
Drosophilidae 217
Eccoptomera 220
Epistomyia 207, 218, 219, 220, 229, 241, 247
Epistomyiini 220, 222, 223, 228, 236, 242
Fenwickia 204, 220, 234, 245, 249
Fenwickiini 220, 234, 236, 242
Gephyromyza 216, 220, 230, 231, 240, 248
Gephyromyzini 220, 222, 230, 236, 237, 242
Gymnomus 220
Helcomyza 216, 242
Helcomyzidae 216, 242
Heleomicra 205, 210, 211, 215 220, 230, 242, 248
Heleomyza 216, 220, 224, 245
Heleomyzinae 216, 224
Heleomyzini 204, 216, 218, 219, 220, 221, 223 224, 225, 236, 237, 242
Heleomyzoidea 221
Heloclusia 220
Helomyza 206, 215, 216, 220, 242
Helomyzides 220
Heteromyza 215, 219, 220, 224, 245, 246
Heteromyzidae 203
Heteromyzides 220
Huttonomyia 220
Ironomyiidae 236
Kiboleria 220
Lauxaniidae 242
Leria 206, 215, 220
Leriinae 220
Leriopsis 205, 209, 215, 217, 220, 229
Listriomastax 216, 220
Lutomyia 220
Mayomyia 216, 217, 218, 220 236, 239, 244, 249
Mayomyiini 220, 221, 236, 242
Meiosimyza 215, 242
Morpholeria 220

Neoecothea 206, 220
Neoleria 220, 224
Neorhinotora 220, 232, 233, 241, 249
Neossos 216, 219, 220, 228, 242
Nephellini 220, 223, 231, 236, 242
Nephellum 218, 220, 221, 231, 232 239, 241, 242, 245, 248
Nephoneura 220, 221, 242
Notomyza 216, 218, 219, 220, 224 229, 230, 241, 248
Notomyzidae 203, 220
Notomyzini 216, 220, 223, 229, 230, 236, 242
Oecothea 206
Oldenbergiella 220, 224
Ollix 204, 206, 207, 215, 217, 218, 225, 242
Opomyzidae 218
Orbellia 219, 220, 224
Ornitholeria 216, 220
Paraneossos 216, 220, 231, 240
Paratrixoscelis 220, 233, 234, 242
Pentachaeta 205, 212, 213, 214, 215, 219 220, 233, 239, 242, 245, 249
Pentachaetini 212, 217, 220, 223, 232 233, 236, 239, 242
Porsenus 204, 220, 225
Prosopantrum 205, 208, 215, 219, 220 224, 229, 230, 236, 241
Protosuillia 225
Pseudoleria 204, 206, 215, 220, 224 225, 240, 244, 246
Pseudopomyzidae 220, 239
Psiloplagia 220, 233, 234, 241
Rhinotora 220, 232, 233, 241, 248
Rhinotoridae 203, 216
Rhinotorinae 220
Rhinotorini 212, 217, 218, 220, 222 228, 231, 232, 236, 237
Rhinotoroides 220, 232, 233, 241, 245
Sapromyza 215, 216, 242
Scathophagidae 225
Scatophagidae 225
Schizophora 203, 236
Schroederella 220
Sciadoceridae 236
Sciomyza 215, 242
Sciomyzoptera 206, 215
Scoliocentra 217, 219, 220, 224, 245, 246
Spanoparea 220
Sphaeroceridae 210, 216
Sphaeroceroidea 221
Spilochroa 220, 234
Strongylophthalmyiinae 224
Stuckenbergiella 217, 218, 220, 233, 234, 236
Suillia 215, 217, 219, 220, 225 240, 242, 244, 246
Suilliinae 225
Suilliini 204, 216, 220, 222, 225, 236, 237
Tanypezidae 218, 224
Tanypezinae 224
Tanypezoinea 224
Tapeigaster 205, 206, 207, 208, 215 220, 225, 245, 246
Tapeigastrini 220, 222, 225, 236
Tapigasterinae 220
Tephritoinea 219, 220
Tephrochlaena 220
Tephrochlamys 205, 219, 220, 224, 225, 244
Tethinidae 216, 220
Tethinosoma 220
Thelida 220
Thyreophorella 220
Thyreophorellinae 220, 221
Trichochlamys 220
Trichoscelis 220
Trixoleria 205, 209, 215, 219, 220
Trixoscelidae 203, 220
Trixoscelididae 216
Trixoscelidini 220,221, 223, 233, 234, 236
Trixoscelis 204, 217, 220, 224, 233, 234 239, 240, 241, 245, 249
Waterhouseia 204, 215, 216, 219, 220 224, 234, 235, 249
Waterhouseiini 215, 220, 222, 234, 236, 242
Xeneura 204, 220, 245
Zachaetomyia 219, 220, 224, 240, 245, 247
Zachaetomyiini 220, 222, 225, 226 227, 236, 242
Zagonia 220, 234
Zentula 205, 212, 213, 215, 220, 232, 242

Warragaia rintouli n.gen., n.sp. (Amphipoda: Urohaustoriidae) from New South Wales, Australia.

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ABSTRACT. A new urohaustoriid genus and species, *Warragaia rintouli*, is described from Jervis Bay, south-eastern Australia. *Warragaia rintouli* is the only urohaustoriid which never has spines or apical setae on the dactyl of peraeopod 5, has a vestigal inner ramus on uropods 1 and 2, and a posterodorsal hook on coxa 7.

BERENTS, PENELOPE B., 1985. *Warragaia rintouli* n.gen., n.sp. (Amphipoda : Urohaustoriidae) from New South Wales, Australia. Records of the Australian Museum 36(5): 253-258.

KEYWORDS: taxonomy, urohaustoriid amphipod, south-eastern Australia.

Urohaustoriids are fossorial amphipods in the superfamily Haustorioidea. Barnard & Drummond (1982) revised the Haustorioidea and erected the family Urohaustoriidae based on collections from Australia.

While studying the life histories of a number of species of amphipods in Jervis Bay, New South Wales, I found a urohaustoriid which could not be assigned to genus. This species has some characters in common with each of three genera described by Barnard & Drummond (1982): *Tottungus*, *Tuldarus* and *Dirimus*.

The diagnosis of *Warragaia* follows the form established by Barnard & Drummond (1982) for urohaustoriids. The length of the whole animal was measured along the mid-dorsal line from the tip of the rostrum to the base of the telson. The method described by Barnard & Drummond (1978) was used for measuring dissected parts. Barnard & Drummond (1982) defined a formula for describing patterns of spines and setae. A modified formula is used herein : E = long or short seta, S = long or short spine.

Material is lodged in the Australian Museum, Sydney, (AM) and the Museum of Victoria, Melbourne, (NMV).

The following abbreviations are used in the figures: A1, 2: antenna 1, 2; G1, 2: gnathopod 1, 2; C3, 4: coxa 3, 4; MD: mandible; MX1, 2: maxilla 1, 2; MP: maxillipeds; P3-7: peraeopod 3-7; T: telson; U1-3: uropod 1-3; l: left; r: right.

Warragaia n.gen.

Diagnosis. Rostrum weak, but head large and cowl-like. Primary flagellum of antenna 1 elongate, accessory flagellum weak. Outer plate of maxilla 1 with 9 spine teeth. Mandibular incisors truncate; right and left laciniae mobiles dissimilar; 1 spine blade on right mandible, 2 spine blades on left mandible. Maxillae 1 and 2, and maxillipeds lacking baler lobes. Coxae 1 and 2 small, coxa 1 larger than coxa 2. Coxae 3 and 4 large, coxa 3 subequal to coxa 4, posteroventral setae small. Coxa 4 without setae. Gnathopod 2 subchelate. Dactyls of peraeopods 5-7 lacking spines, and subapical and apical setae in both males and females. Article 2 of peraeopod 5 strongly expanded; article 2 of peraeopods 6 and 7 of moderate width. Pleopod 3 smaller than pleopod 2. Epimeron 1 scarcely differentiated; epimera 2 and 3 of similar size, lacking setae. Peduncle of uropods 1 and 2 sparsely setose laterally. Uropod 1 outer ramus with 2-3 plumose apical setae; inner ramus very reduced, fused to peduncle. Uropod 2 outer ramus with 1-2 plumose apical setae; inner ramus very reduced, fused to peduncle. Uropod 3 outer ramus larger than inner ramus, 2-articulate, with 1-2 plumose apical setae. Telson short, entire, wider than long.

Type-species. *Warragaia rintouli* n.sp.

Etymology. *Warragaia* is derived from an aboriginal word, 'warragai', meaning 'plenty of sand'. The gender is feminine.

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Warragaia rintouli **n.sp.**

Figs 1–3

Type-material. HOLOTYPE, male, 1.76 mm, AM P34773; ALLOTYPE, 1.64 mm, AM P34774; 48 PARATYPES, AM P34775; 1 PARATYPE, NMV J10779: 1 km off Moona Moona Creek, Jervis Bay, New South Wales, Australia, 35°03'S, 150°41'E, airlifted sand and shelly sand, 8 m, P.B. & P.M. Berents, 17 November, 1981.

Additional material. Sixty-two specimens, AM P34776, as for holotype, 18 February, 1983; 9 specimens NMV J10780, as for holotype, 29 April, 1983.

Description. Holotype male, 1.76 mm. *Head* about 0.8 times as long as wide. *Antenna 1*: peduncle 1.3 times as long as flagellum; flagellum 9-articulate, each article bearing aesthetascs; accessory flagellum 3-articulate. *Antenna 2*: articles 4 and 5 of peduncle with mid-dorsal armature dominated by spines, article 4 SESSESSSSSSESS, article 5 SSSSESS; flagellum 6-articulate.

Mandible: incisor truncate; right lacinia mobilis narrow, spatulate (may be obscured by curved edges of incisor); left lacinia mobilis triangular with two apical teeth; 1 spine blade on right mandible, 2 spine blades on left mandible; molar triturating; palp 3-articulate, article 1, 0.4 times as long as article 2, articles 2 and 3 subequal, article 3 with 3 awned spines and 3 shorter simple spines. *Maxilla 1*: inner plate linguiform with 1 sub-apical plumose seta; outer plate truncate bearing 9 spine teeth; palp with 3 apical plumose setae. *Maxilla 2*: inner plate ovate with apical setae and submarginal setae; outer plate truncate, with apical setae. *Maxillipeds*: inner plate with medial plumose seta, bearing apical plumose setae and stout spines; outer plate with setal/spine formula E-EESEEESESS-E; palp 4-articulate, inner margin of article 2 densely setose, dactylus slender with 3 setae and apical spine.

Gnathopod 1: simple; coxa extended anteroventrally; article 2 slender; article 5 expanded, posterior margin setose; article 6, 0.6 times as long as article 5, distally setose; dactylus slender with setule. *Gnathopod 2*: subchelate; coxa smaller than coxa 1; article 2 slender, posterior margin with long setae; article 3 bearing long setae with terminal pectination; article 5 elongate, posterior margin sparsely setose; article 6, 0.7 times as long as article 5, palm setose, confluent with posterior margin; dactylus recurved with setule on inner margin.

Peraeopod 3: coxa large, 1.2 times as wide as long, anteroventral corner broadly rounded, posteroventral corner drawn to subacute point; article 5 posterior margin with 3 stout spines, distal margin bearing sharp denticles; article 6 subequal to article 5, with 7 stout spines, distal margin bearing sharp denticles; dactylus slender, 1.4 times as long as article 6, cusp near apex. *Peraeopod 4*: similar size and proportions to peraeopod 3 except coxa quadrate. *Peraeopod 5*: coxa 1.5 times as wide as long; article 2 broadly expanded, almost as wide as long; articles 3–6 with groups of spines; article 5 subequal in length to article 6; dactylus slender, armed with denticles, 0.8 times as long as article 6, plumose setule at M 30, cusp near apex. *Peraeopod 6*: longer and less spinous than peraeopod 5; coxa 1.4 times as wide as long; article 2 moderately expanded, 0.6 times as wide as long, anterior margin bearing 4 groups of spines; article 4 posterior margin with 2 long plumose setae; articles 4–6 with groups of spines; dactylus slender, setule at M 41, cusp near apex. *Peraeopod 7*: similar size and proportions to peraeopod 6 except coxa with posterodorsal hook; article 2 anterior margin with 3 spines; article 4 without long plumose setae.

Pleopods: peduncles of all pleopods short, wider than long; inner rami shorter than outer rami; pleopod 3 shorter than pleopod 2.

Epimeron 1: scarcely differentiated. *Epimera 2 and 3*: similar in size, lacking setae, postero-ventral margins rounded.

Uropod 1: peduncle with 3 plumose setae laterally; inner ramus very reduced, fused to peduncle, bearing 1 plumose apical seta; outer ramus with 2 plumose apical setae, 2 plumose setae along inner margin. *Uropod 2*: similar to uropod 1 except peduncle without lateral setae. *Uropod 3*: inner ramus with 2 apical plumose setae, inner margin with 3 plumose setae; outer ramus 2-articulate, 1 apical seta. *Telson*: entire, wider than long.

Allotype female, 1.64 mm. Similar to holotype except in following ways: *Antenna 1*: article 1 of peduncle with 3 stout mid-dorsal brush setae; primary flagellum 6-articulate, aesthetasc on articles 5 and 6. *Antenna 2*: formula for facial armature of article 4 SSESSSSSSESS, article 5 SSESS. *Maxillipeds*: outer plate with setal/spine formula E-EESEEESESESE. *Peraeopod 7*: article 2 anterior margin with 4 spines. *Uropod 1*: peduncle with 2 plumose setae laterally. *Uropod 3*: inner margin of inner ramus with 2 apical setae; outer ramus bearing 2 apical setae.

Largest male: 1.92 mm. Largest female: 2.32 mm (ovigerous).

Variation. *Antenna 1*: most specimens have 3 stout mid-dorsal brush setae on article 1 of peduncle as described for allotype. *Antenna 2*: the facial armature of article 4 of peduncle varies although spines are dominant. The formulae are characterized by a middle group of 6 or 7 spines followed by ESS (occasionally ESSS). The proximal end varies from ESESSE to SSE. *Maxillipeds*: outer plate may have 4 or 5 spines. *Gnathopod 2*: palm may be more setose in large females. *Peraeopod 3*: article 6 may have 6 or 7 stout spines. *Peraeopods 6 and 7*: dactylus occasionally with setule at cusp. *Uropod 1*: outer ramus bearing 2 or 3 plumose apical setae. *Uropod 2*: outer ramus bearing 1 or 2 plumose apical setae. *Uropod 3*: outer and inner rami with 1 or 2 plumose apical setae. The number of groups of lateral setae on the inner and outer margins is variable.

Etymology. The species is named for Ian Rintoul, 13/12/50–26/3/84.

Remarks. *Warragaia rintouli* belongs to the group of urohaustoriid genera without spines on the dactyl of peraeopod 5 and with a weak accessory flagellum. The other genera in this group are *Dirimus*, *Tottungus* and

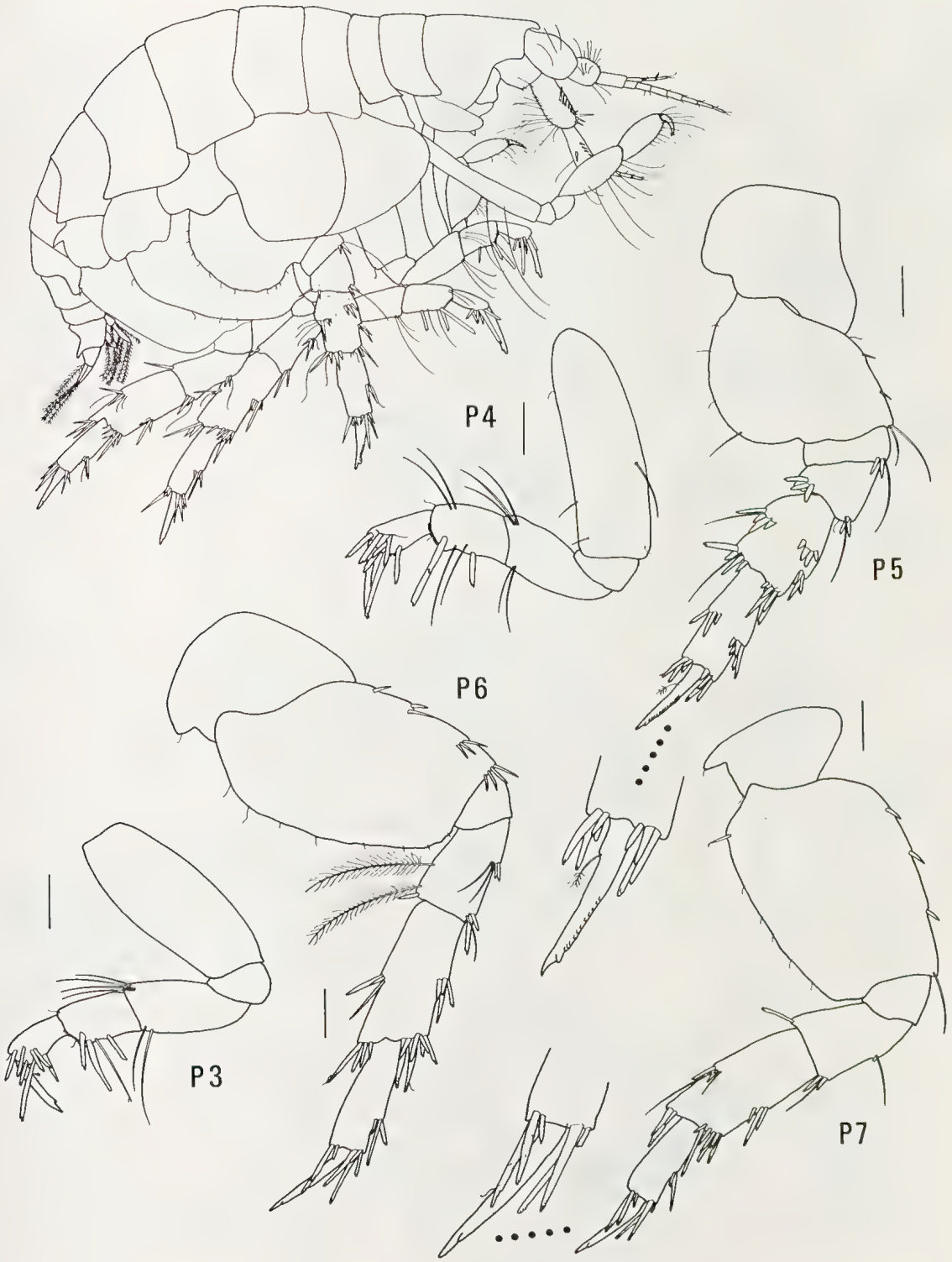

Fig. 1. *Warragaia rintouli* n.gen. n.sp.: whole animal, paratype, female, 1.92 mm; peraeopods, holotype, male, 1.76 mm. Jervis Bay, N.S.W., Australia. **Scale** represents 0.1 mm.

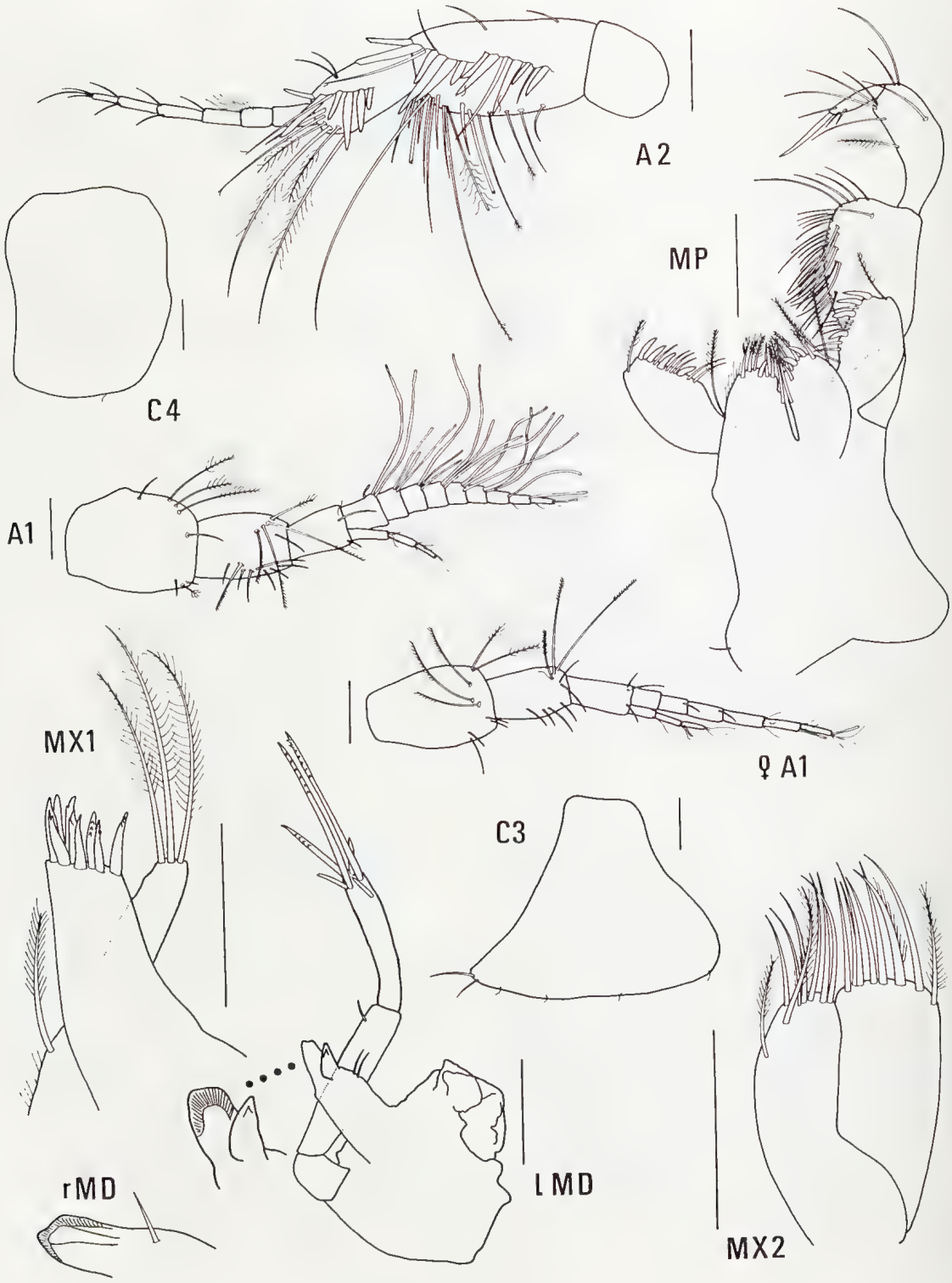

Fig. 2. *Warragaia rintouli* n.gen. n.sp.: holotype, male, 1.76 mm; allotype, 1.64 mm. Jervis Bay, N.S.W., Australia. Scale represents 0.1 mm.

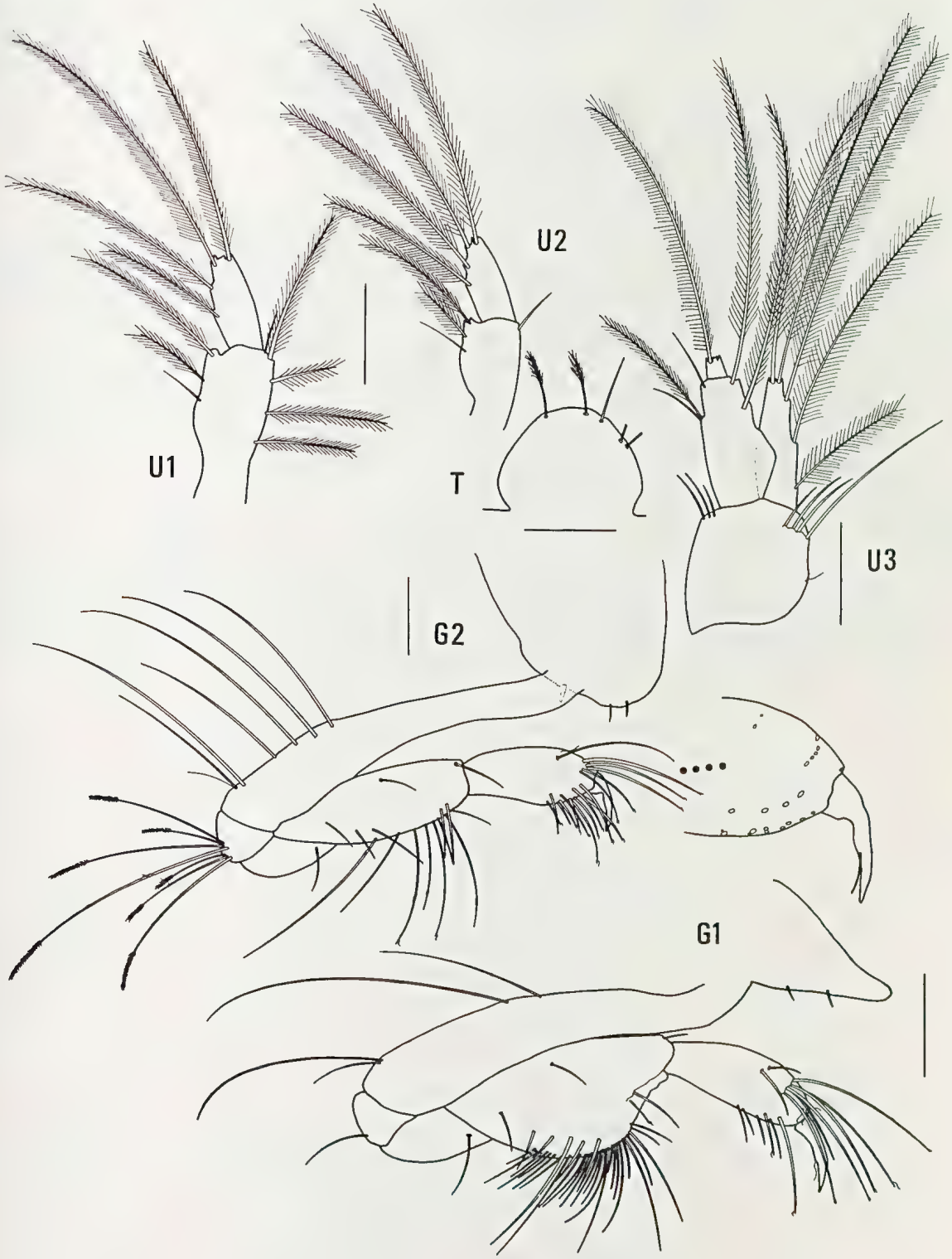

Fig. 3. *Warragaia rintouli* n.gen. n.sp.: holotype, male, 1.76 mm. Jervis Bay, N.S.W., Australia. **Scale** represents 0.1 mm.

Tuldarus. *Warragaia rintouli* shares other diagnostic characters with each of the above genera and has some unique characters. *Warragaia rintouli* is the only urohaustoriid which never has spines or apical setae on the dactyl of peraeopod 5, has a vestigial inner ramus on uropods 1 and 2, and a posterodorsal hook on coxa 7.

Warragaia rintouli and *Dirimus* share the following characters: a large cowl-like head; 9 spines on the outer plate of maxilla 1; 1 spine-blade on the right mandible and 2 spine-blades on the left mandible; pleopod 3 smaller than pleopod 2; epimeron 2 lacking facial setae; epimera 2 and 3 with rounded posteroventral margins.

Warragaia rintouli resembles *Tottungus* in the small coxae 1 and 2 with coxa 1 larger than coxa 2; pleopod 3 smaller than pleopod 2; the reduction in size of the setae on coxae 3 and 4. *Warragaia* and *Tottungus* are the only urohaustoriids with subchelate gnathopod 2 but the palms of the second gnathopods in these genera are different. The palm of *Tottungus* is almost transverse, serrate and not confluent with the posterior margin. The palm of *Warragaia* is subchelate, smooth and confluent with the posterior margin.

Warragaia shares the following characters with *Tuldarus*: lack of baler lobe on maxillae 1 and 2 and maxillipeds; coxa 3 subequal to coxa 4; left lacinia mobilis triangular with 2 teeth.

There are probably many Australian urohaustoriids yet to be discovered and future work may lead to changes in the status of these genera. Barnard & Drummond (1982) have worked predominantly with collections from Westernport and Port Phillip Bay (Victoria), plus some material from Moreton Bay (Queensland) and the Hunter River district (NSW). The urohaustoriids from the remainder of the Australian coast have not been studied. As more material is examined it will be possible to assess the value of characters whch are used in the diagnoses of urohaustoriid genera and species.

Distribution. Jervis Bay, New South Wales (type-locality).

ACKNOWLEDGEMENTS. I thank Dr D.J.G. Griffin, Director and Dr J.K. Lowry, of the Australian Museum for allowing me the use of the facilities of the Australian Museum. I thank Mr P.M. Berents for assisting with field work and proof reading; Mrs M.M. Drummond, Ms H. Stoddart, Dr J. Just, Dr J.L. Barnard and Dr J.K. Lowry for checking the manuscript; Ms J. Gates for typing the manuscript; Dr G. Poore for the opportunity to examine material from the Museum of Victoria.

The work was carried out while the author was in receipt of a Commonwealth Postgraduate Research Award.

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The Ampeliscid Amphipods of South-eastern Australia (Crustacea) ..... Page 259
..... J.K. LOWRY AND G.C.B. POORE

Occurrences and origins of Gem Zircons in Eastern Australia ..... Page 299
..... J.D. HOLLIS AND F.L. SUTHERLAND

The Ampeliscid Amphipods of South-eastern Australia (Crustacea)

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Abstract. The Ampeliscid amphipods of south-eastern Australia are studied in detail for the first time. The two known species, *Ampelisca australis* Haswell and *A. acinaces* Stebbing, are rediscovered, and 15 new species in the genera *Ampelisca, Byblis* and *Haploops* are described. These include *Ampelisca ballina*, *A. bidura*, *A. calooma*, *A. dimboola*, *A. euroa*, *A. jingera*, *A. narooma*, *A. tilpa*, *A. toora*, *A. yuleba*, *Byblis bega*, *B. gerara*, *B. mildura*, *B. tinamba* and *Haploops oonah*. A key is provided to the ampeliscid species of south-eastern Australia.

Lowry, J.K. & G.C.B. Poore, 1985. The ampeliscid amphipods of south-eastern Australia (Crustacea). Records of the Australian Museum 36(6): 259–298.

Keywords: taxonomy, Amphipoda, Ampeliscidae, *Ampelisca, Byblis, Haploops.*

The Australian ampeliscid amphipods have never been studied in detail. Only two species, *Ampelisca australis* Haswell, 1879, and *A. acinaces* Stebbing, 1888, have been recorded. Stebbing (1910) reported *Ampelisca pusillus* Sars from south-eastern Australia but the record is dubious. In collections from the Australian Museum, the Museum of Victoria and from other sources we have rediscovered *A. australis* and *A. acinaces*. In addition, we have discovered 14 new species in the genera *Ampelisca*, *Byblis* and *Haploops*. This is only part of our collection, and indicates that when the Australian ampeliscids are better known the number of species will be similar to, or exceed that of, other well-known areas such as New England (Bousfield, 1973), southern California (J.L. Barnard, 1960), the north-eastern Pacific (Dickinson, 1982, 1983), the Mediterranean Sea (Bellan-Santini, 1982), the British Isles (Lincoln, 1979) and southern Africa (Griffiths, 1976).

Groups of ampeliscid species are usually very similar in general morphology and differ most clearly through distinctions in antennae, gnathopod 1, peraeopod 7, urosome, uropods and telson. In this paper we have diagnosed species using these characters plus a few others, thereby avoiding long, repetitious descriptions. Later, when more material is available for study, certain species such as *A. australis*, may be recognized as complex species groups. This paper illustrates the diagnostic characters of each species and gives a lateral view of the whole animal for most species. In addition, a key is provided to aid in identification.

Most of the material used in this study comes from macrobenthic surveys of the bays and continental shelf and slope of south-eastern Australia, between southern Queensland and Tasmania. The New South Wales material comes from dredge samples made by the FRV *Kapala* (Division of Fisheries, New South Wales Department of Agriculture), grab samples taken during the Australian Museum's Hunter District Water Board Survey (HDWBS) and grab and SCUBA samples taken during the Australian Museum Shelf Benthic Survey (AMSBS). Collections from the Hawkesbury River and Broken Bay were made by the Department of Marine Ecology, Australian Museum (AMHRS) and collections from Botany Bay were made by the State Pollution Control Commission (SPCC). Most of this material is held in the Australian Museum (AM).

Collections from Bass Strait were obtained from the Museum of Victoria's Bass Strait Survey (BSS). The Victorian Ministry for Conservation, Marine Studies Group, sampled in Western Port as part of the Crib Point Benthic Survey (CPBS) and the Westernport Bay Environmental Study (WBES). The Marine Studies Group also sampled in Port Phillip Bay as part of the Port Phillip Bay Environmental Study (PPBES). Details of this work were reported by Poore, *et al.* (1975). These collections are held in the Museum of Victoria, Melbourne (NMV) (formerly known as the National Museum of Victoria).

Benthic samples from Moreton Bay made by the Department of Zoology, University of Queensland (QUBS) are also used in this study. The material is held in the Queensland Museum, Brisbane (QM).

New specific epithets are Australian aboriginal place names chosen only for their euphony, and are treated as arbitrary combinations of letters. The following abbreviations are used in the figures: Al,2: antenna 1,2; Cl: coxa 1; EPl–3: epimeron 1–3; Gl: gnathopod 1; MD: mandible; MXl: maxilla 1; MP: maxilliped; MPp: maxillipedal palp; P3–7: peraeopod 3–7; T: telson; Ul–3: uropod 1–3; UR: urosome.

Key to Species of Ampeliscidae from South-eastern Australia

1. Head as long as deep; lobe on article 2 of peraeopod 7 not expanded distally, with posterior margin nearly vertical.....*Haploops* (one species, *H. oonah*)

——Head longer than deep; lobe on article 2 of peraeopod 7 expanded distally, with posterior margin oblique.....2

2. Peraeopod 7, free anterior margin of article 2 lacking setae near junction with article 3, article 7 broad at base, not spine-like.....*Ampelisca*... 3

——Peraeopod 7, free anterior margin of article 2 setose near junction with article 3, article 7 spine-like.....*Byblis*... 14

3. Uropod 3, outer ramus ovate; telson longer than broad, with spines along the cleft and terminally.....*A. bidura*

——Uropod 3, rami lanceolate; telson as long as broad, with spines mid-dorsally on each lobe.....4

4. Antenna 1 much longer than peduncle of antenna 2; peraeopod 7 with article 2 overlapping article 4.....5

——Antenna 1 shorter than or subequal to peduncle of antenna 2; peraeopod 7 with article 2 not overlapping article 4.....8

5. Peraeopod 7, article 3 longer than article 4; uropod 2, outer ramus without a subterminal spine; coxae 1–3 without posteroventral hooks; mandibular palp, article 2 inflated.....*A. euroa*

——Peraeopod 7, article 3 shorter than or equal to article 4; uropod 2, outer ramus with a subterminal spine; coxae 1–3 with posteroventral hooks; mandibular palp, article 2 linear.....6

6. Without eyes or cuticular lenses; uropod 2, rami each with one dorsal spine row; peraeopod 7, article 2 without setae along distal margin.....*A. narooma*

——With 2 pairs of eyes and cuticular lenses; uropod 2, rami each with 2 dorsal spine rows; peraeopod 7, article 2 with dense setal row along distal margin.....7

7. Antennae 1 and 2 subequal; epimeron 3 with square posteroventral corner.....*A. calooma*

——Antenna 1 shorter than antenna 2; epimeron 3 with strongly projecting tooth.....*A. jingera*

8. Peraeopod 7, article 6 linear, more than twice as long as broad.....9

——Peraeopod 7, article 6 inflated, rarely more than 1.5 times as long as broad.....10

9. Urosomites 2-3 with a prominent dorsal keel; antenna 1, article 2 more than twice length of article 1; epimeron 3 without a posteroventral tooth.....*A. acinaces*

——Urosomites 2-3 without a dorsal keel; antenna 1, articles 1 and 2 subequal; epimeron 3 with a posteroventral tooth.....*A. ballina*

10. Urosomite 1 with a saddle-shaped dorsal keel; peraeopod 7, anterodistal corner of lobe of article 2 obscuring distal margin of article 3.....*A. toora*

——Urosomite 1 with a simple or upturned dorsal keel; peraeopod 7, anterodistal corner of lobe of article 2 not obscuring distal margin of article 3.....11

11. Uropod 2, inner ramus with two dorsal rows of short spines.....*A. australis*

——Uropod 2, inner ramus with a single dorsal row of long and short spines.....12

12. Urosomite 1 with prominent dorsal keel, obliquely truncate posteriorly; peraeopod 7, ventral margin of article 2 transverse, reaching only as far as angle on posterior margin of article 3; antenna 1 reaching only to end of article 4 of antenna 2.....*A. dimboola*

——Urosomite 1 with a more or less acutely projecting dorsal keel; peraeopod 7, ventral margin of article 2 oblique, reaching beyond angle on posterior margin of article 3; antenna 1 reaching well along or beyond article 5 of antenna 2.....13

13. Peraeopod 7, article 2 about as broad as length of anterior margin; uropod 2, outer ramus with 2 long subterminal spines; antenna 1, article 1 much longer than broad.....*A. tilpa*

——Peraeopod 7, article 2 narrower than length of anterior margin; uropod 2, outer ramus with 1 longer subterminal spine; antenna 1, article 1 slightly longer than broad.....*A. yuleba*

14. Without cuticular lenses; gnathopod 1 subchelate, palm slightly oblique; telson, lobes with an apical spine.....*B. gerara*

——With 2 pairs of eyes and cuticular lenses; gnathopod 1 simple; telson, lobes without apical spines.....15

15. Antennae subequal; lobe on peraeopod 7 broadly rounded, truncate, reaching slightly beyond distal margin of article 4.....*B. tinamba*

——Antenna 1 shorter than antenna 2; lobe on peraeopod 7 elongate, reaching well along article 5.....16

16. Telson distally truncate; coxa 1 broadly convex ventrally, not reaching anterior margin of head.....*B. mildura*

——Telson distally rounded; coxa 1 tapering distally, straight ventrally, reaching anterior margin of head.....*B. bega*

Family Ampeliscidae

Ampelisca Krøyer

Type-species. *Ampelisca eschrichtii* Krøyer, 1842 (original designation).

Remarks. Species of the genus *Ampelisca* are distinguished by the absence of setae on the anterior margin of article 2 of peraeopod 7, and the broadly-based article 7 on the same limb. Dickinson (1982) diagnosed the genus in detail and provided a key to species in the north-eastern Pacific region. J.L. Barnard (1960) provided a key to the species then known.

Ampelisca acinaces Stebbing

Figs 1, 2

Ampelisca acinaces Stebbing, 1888: 1036, pls 101, 102. — Della Valle, 1893: 476, pl. 57 fig. 43; Stebbing, 1906: 108, figs 25, 26; 1910: 635; Sheard, 1937: 19; J.L. Barnard, 1958: 17; 1960: 7, 18; Imbach, 1967: 63.

not *Ampelisca acinaces*. — Thomson, 1902: 464; Chilton, 1906: 268; 1917: 87 (as a junior synonym of *A. eschrichtii*); K.H. Barnard, 1931: 119.

Material examined. 2 specimens AM P34152, east of Long Reef, New South Wales, 33°46'S 151°43'E, dredged, 176 m, 5 December 1977, *Kapala* station K77-23-01.

Diagnosis. Head about 1.4 times as long as deep without a rostrum; anteroventral corner angular, anteroventral margin oblique; 2 pairs of eyes, each with a cuticular lens. Antenna 1 nearly as long as peduncle of antenna 2; peduncular article 2 at least 2.3 times as long as article 1. Antenna 2 as long as body. Coxae 1–3 with hooks on posteroventral corners. Peraeopod 4 with article 4, 3.5 times as long as wide. Peraeopod 7, distal corner of article 2 not reaching distal margin of article 3, posterior margin oblique, posteroventral corner rounded, ventral margin slightly oblique, setose; article 3 about 1.6 times as long as article 4; articles 4 and 5 bearing well-developed anterior lobes; article 6 not inflated, about 2.5 times as long as broad and longer than articles 4 and 5 combined. Epimera 1–3 with broadly rounded posteroventral corners. Urosomite 1

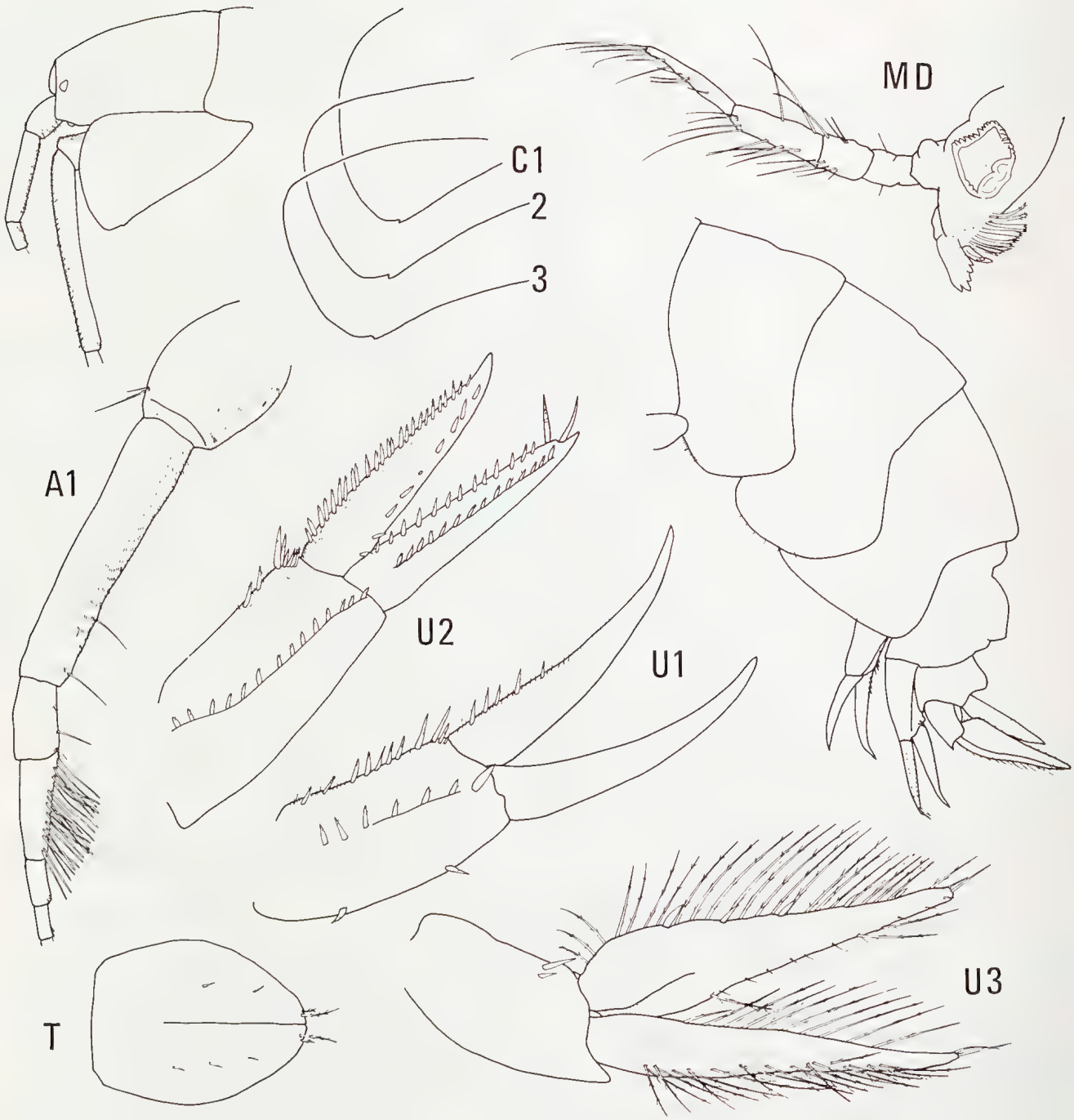

Fig. 1. *Ampelisca acinaces* Stebbing, 1888, male, east of Long Reef, New South Wales.

with a long, even dorsal keel; urosomites 2–3 with a triangular dorsal crest. Uropod 2, inner ramus with 2 dorsal rows of short spines, outer ramus with 2 dorsal rows of short spines, plus 2 long subterminal spines. Uropod 3, rami narrowly lanceolate, both with plumose setae. Telson 1.5 times as long as broad, cleft 0.7 times length, with a row of mid-dorsal setae and 2 apical setae on each lobe.

Remarks. *Ampelisca acinaces* has remained unreported since its original description by Stebbing (1888). The material we have examined from collections made recently off the coast of New South Wales by the FRV *Kapala* agrees in all details with Stebbing's *Challenger* specimens.

Along the east coast of Australia, *A. acinaces* is most closely related to *A. ballina* and differs from it in the length of article 2 of the peduncle of antenna 1, the head shape, the rounded posteroventral corner of epimeron 3, and the raised dorsal keel of urosomites 2–3.

Distribution. New South Wales; shelf, 64–176 m.

Ampelisca australis Haswell

Figs 3, 4

Ampelisca australis Haswell, 1879: 257, 258, pl. 9 fig. 1. –

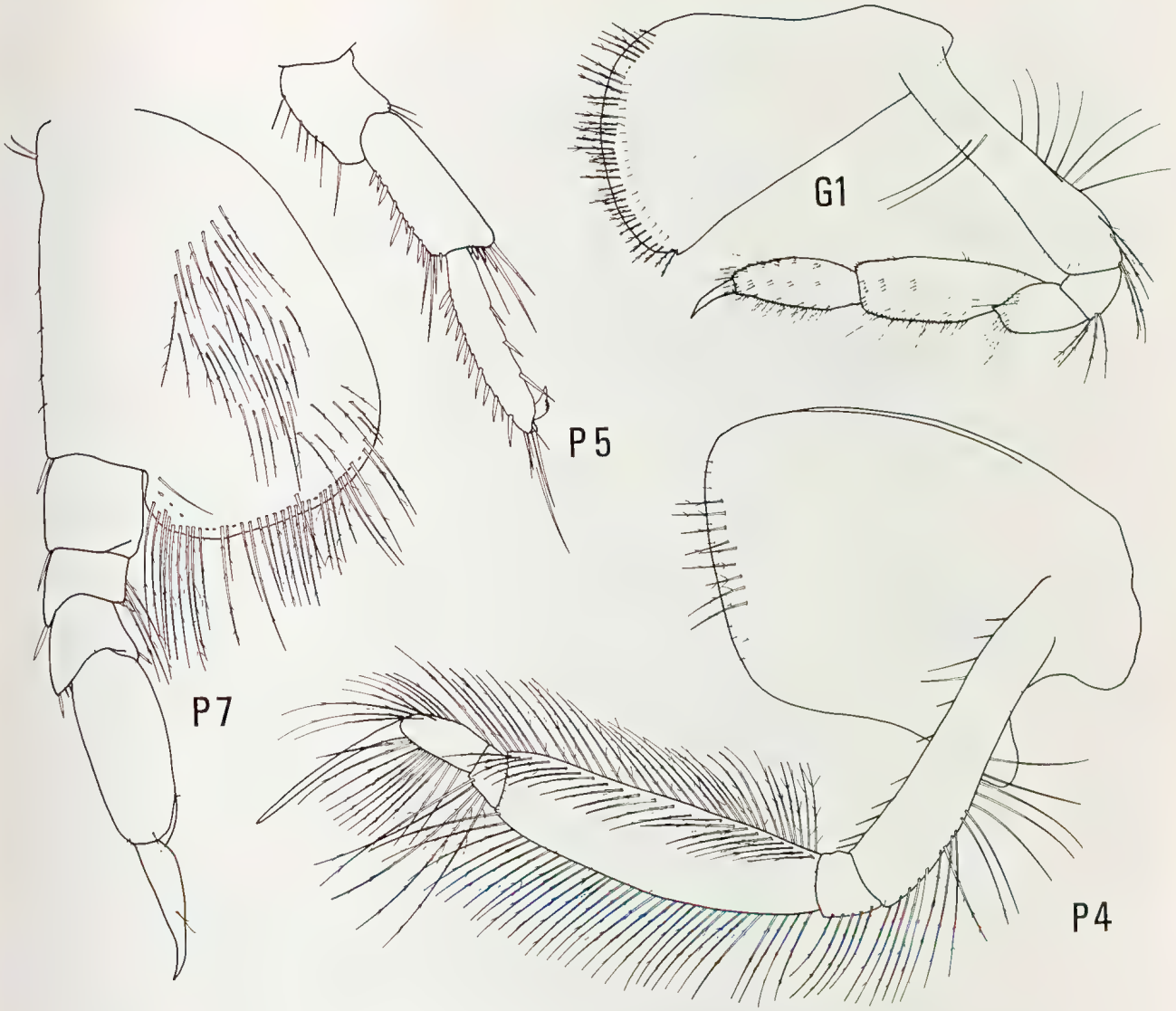

Fig. 2. *Ampelisca acinaces* Stebbing, 1888, male, east of Long Reef, New South Wales.

1882: 235, 236; 1885: 97, 98, pl. 12 figs 11–16, pl. 13 fig.4 (specimens from Port Jackson only); Della Vale, 1893: 471;Stebbing, 1906: 104; 1910: 634; Sheard, 1937: 19; J.L.Barnard, 1958: 19; 1960: 9; 1974: 140; Imbach, 1967: 63.

Ampelisca sp. 3. — Poore *et al.*, 1975: 33, 65.

not *Ampelisca australis*. — Schellenberg, 1938: 6–8, fig. 2; J.L. Barnard, 1965: 463 (table).

Material examined. One specimen, AM P3431, Port Jackson, New South Wales, 9–11 m; 10 specimens, AM P34155 and NMV J2170, east of Long Reef, New South Wales, dredged, 175 m, 5 December 1977, *Kapala* station K77-23-01; 30 specimens, AM P34126, east of Bondi, New South Wales, 80 m, dredged, R. Springthorpe, 11 December 1980, *Kapala* station K80-20-11; 164 specimens, AM P22672, P22673, P22675 and P22679 to P22682, east of Malabar, New South Wales, 31–82 m, fine sand to gravel, AMSBS stations; 2 specimens, AM P34138 and P34139, east of Wollongong, New South Wales, dredged, 277 m, 13 December 1978, *Kapala* station K78-27-08; 26 specimens, AM P34165, off Moona Moona Creek, Jervis Bay, New South Wales, 8 m, P.B. and P.M. Berents, 21 February 1982; 18 specimens, NMV J2215 to J2124, Western Port, Victoria, 2–16 m, muddy to shelly sand, CPBS and WBES stations; 23 specimens, NMV J2125, J2126, Port Phillip Bay, Victoria, 4–9 m, sand, PPBES stations; 300+ specimens, NMV J2127 to J2132, J7101, J7105, J7711 to J7726, throughout Bass Strait, 16–60 m, from 19 BSS stations.

Diagnosis. Head about 1.4 times as long as deep with a very short rostrum; anteroventral margin oblique; 2 pairs of eyes, each with a cuticular lens. Antenna 1 shorter than peduncle of antenna 2, just exceeding article 4; peduncular article 2 about 1.3 times as long as article 1. Antenna 2 half of two-thirds as long as body. Coxae 1–3 with well-developed posteroventral hooks. Peraeopod 4 with article 4 about 2.8 times as long as broad. Peraeopod 7, article 2 with posteroventral corner rounded, ventral margin oblique, slightly convex and setose, distal corner sharp, not reaching distal margin of article 3; articles 3, 4 and 5 subequal in length; articles 4 and 5 bearing anterior

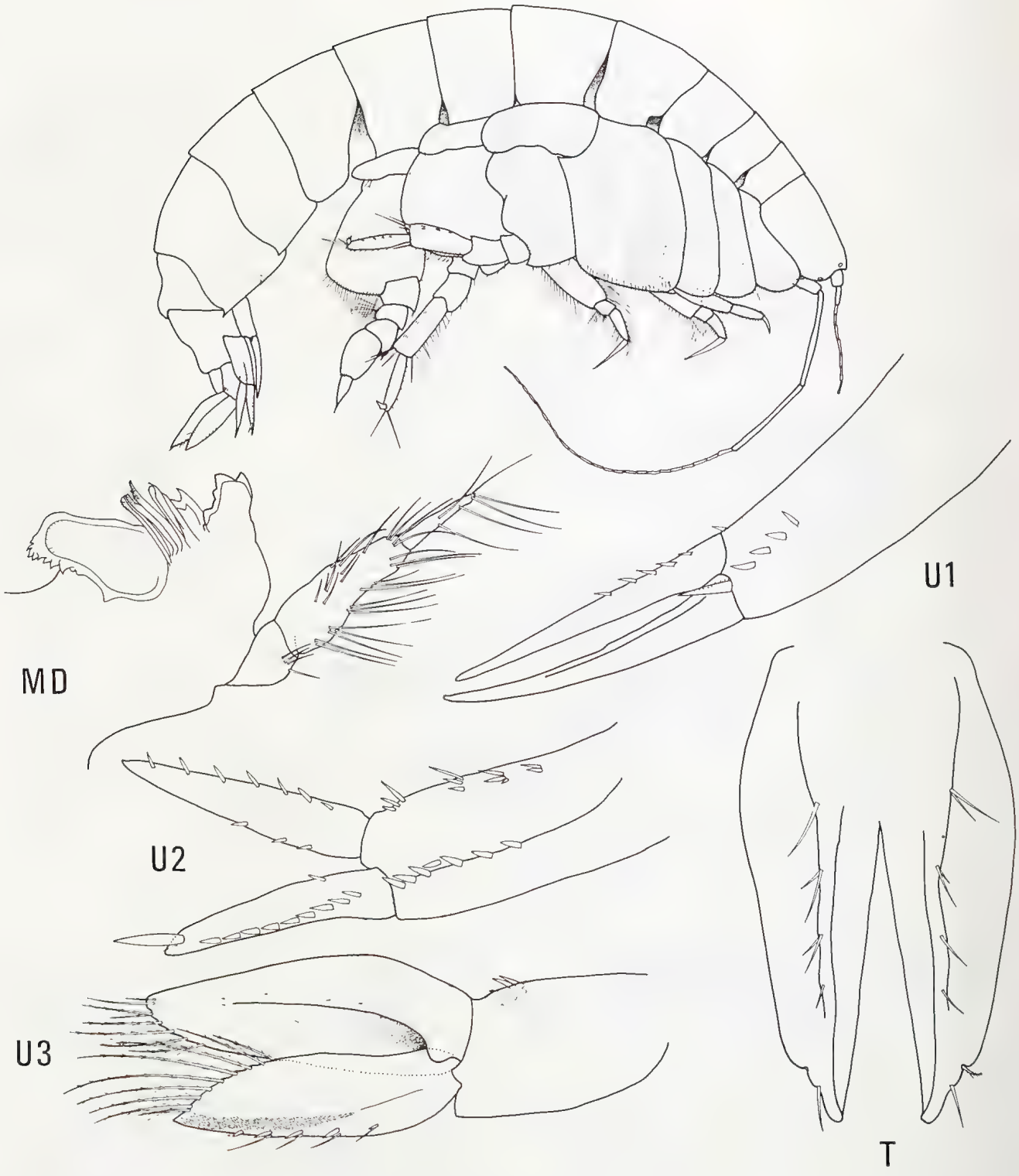

Fig. 3. *Ampelisca australis* Haswell, 1880, female, 15.1 mm, Port Phillip Bay, Victoria.

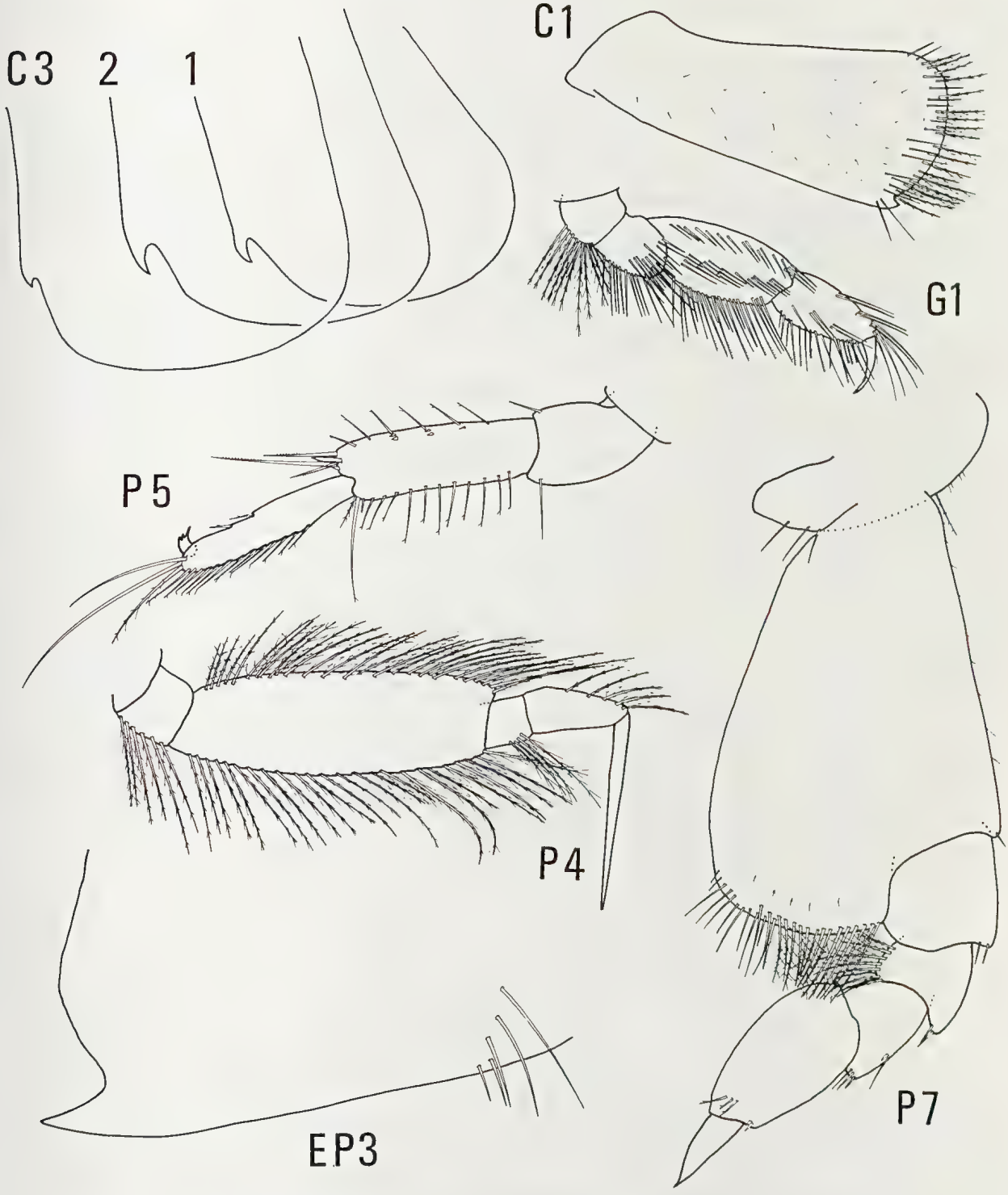

Fig. 4. *Ampelisca australis* Haswell, 1880, female, 15.1 mm, Port Phillip Bay, Victoria.

lobes; article 6 inflated, about 1.7 times as long as broad and nearly 1.5 times as long as articles 4 and 5 combined. Epimeron 1 with rounded posteroventral corner; epimeron 2, posteroventral corner with an acutely projecting tooth; epimeron 3, posteroventral corner with shallow sinus and acutely projecting tooth. Urosomite 1 with a dorsal keel, rounded posteriorly. Coalesced urosomites 2 and 3 with sinuoid dorsal margin. Uropod 2, both rami with 2 rows of minute dorsal spines, shorter outer ramus with a strong subterminal spine. Uropod 3, rami subequal in length, broadly lanceolate; inner ramus with long setae along inner distal margin; outer ramus with plumose setae along inner distal margin; outer margin with a row of short spines and a narrow strip of minute denticles distolaterally. Telson 1.8 times as long as broad, cleft 0.7 times length, with a row of mid-dorsal setae and a pair of subapical sensory setae on each lobe.

Remarks. The original decription of *Ampelisca australis* Haswell, 1880, is not very detailed and the only material labeled as 'type' (AM P3431) is probably not Haswell's type material but a later collection. Fortunately Haswell illustrated the nearly rudimentary first antenna of *A. australis* which distinguishes this species from all others in south-eastern Australia. This allowed us to identify new material in our collections with Haswell's description of *A. australis*. The so-called 'type' specimen also has a rudimentary antenna 1 and is conspecific.

Ampelisca australis is easily distinguished by antenna 1, but it is closely related to at least four other species in south-eastern Australia: *A. dimboola*, *A. tilpa*, *A. toora* and *A. yuleba*. All of these species are characterized by having uropod 3 with broadly lanceolate rami bearing swimming setae on the inner distal margins and a band of minute denticles on the outer margin of the inner ramus. They have a short posteroventral lobe on article 2 of peraeopod 7 and a broad article 6, and their telsons are longer than broad with a row of mid-dorsal setae on each lobe.

Distribution. New South Wales, Bass Strait, Victoria and Tasmania; shelf and bays, 9–293 m.

Ampelisca ballina n.sp.

Figs 5, 6

Type-material. HOLOTYPE: male, 14.4 mm, AM P22666 (with 4 slides), east of Malabar, New South Wales, 33°58'S 151°33'E, 187 m, dredged, 9 August 1973, AMSBS station 44. PARATYPE: 1 specimen, AM P34151, south-east of Broken Bay, New South Wales, 33°43'S 151°40'E, dredged, 143 m, 5 December 1978, *Kapala* station K78-26-02.

Diagnosis. Head about 1.4 times as long as deep, anteroventral margin slightly concave; 2 pairs of eyes, each with a cuticular lens. Antenna 1 nearly as long as peduncle of antenna 2; peduncular article 2 subequal in length to article 1. Antenna 2, length unknown, greater than half body length. Coxae 1 and 2 with small posteroventral hooks. Coxa 3 with rounded posteroventral corner. Peraeopod 4 with article 4, 3.3 times as long as wide. Peraeopod 7, posterior margin of article 2 broadly rounded, widest at midpoint and bearing plumose setae along distal half, distal corner rounded, extending beyond distal margin of article 3; article 3 about 1.5 times as long as article 4; article 4 with well-developed anterior lobe; article 6 not inflated, 2.3 times as long as broad and subequal in length to articles 4 and 5 combined. Epimera 1 and 2 with broadly rounded posteroventral corners; epimeron 3, posteroventral corner with acute tooth and deep sinus. Urosomites 1 and 2–3 each with a shallow dorsal sinus. Uropod 2, both rami with 2 dorsal rows of spines, outer ramus with long subterminal spine. Uropod 3, rami elongate, subequal in length, lanceolate; inner ramus with a row of spines along inner margin; outer ramus with a short row of distal plumose setae along inner margin. Telson 1.3 times as long as broad, cleft 0.6 times length; with a short row of mid-dorsal spines, a pair of proximolateral setae and a pair of distolateral setae on each lobe.

Remarks. *Ampelisca ballina* is most closely related to *A. acinaces*. Both species are characterized by long, slender, lanceolate rami on uropod 3 and a linear article 6 on peraeopod 7. *Ampelisca ballina* differs from *A. acinaces* in having a short second article on the peduncle of antenna 1 and a hook on the posteroventral corner of epimeron 3.

Ampelisca ballina appears to be closely related to *A. hancocki* J.L. Barnard from the eastern Pacific Ocean. The most obvious differences between them include the length to width ratio of article 6 of peraeopod 7, the dorsal setation of the telson and the lack of a subapical spine on the outer ramus of uropod 2 in *A. hancocki*.

Distribution. New South Wales; shelf 143–187 m.

Ampelisca bidura n.sp.

Figs 7, 8

Type-material. HOLOTYPE: 4.4 mm, AM P34131 (with 3 slides), east of Bondi, New South Wales, 33°52'S 151°23'E, 80 m, dredged, R. Springthorpe, 11 December 1980, *Kapala* station K80-20-11. PARATYPES: 2 specimens, AM, P34132, type-locality; 3 specimens, NMV J1572, east of Broken Bay, New South Wales, 33°32'S 152°08'E, 914 m, dredged, R. Springthorpe, 10 December 1980, *Kapala* station K80-20-08; 1 specimen, AM P34133, east of Long Reef, New South Wales, 33°46'S 151°43'E, 176 m, dredged, 5 December 1977, *Kapala* station K77-23-01; 4 specimens, AM P25472, east of Port Kembla, New South Wales, 34°26-27'S 151°27'E, 1200 m, *Globigerina* ooze, dredged, J.K. Lowry, 13 December 1976, *Kapala* station K76-23-02.

Additional material. 26 specimens, AM P34157, north-east of Long Reef, New South Wales, dredged, 176 m, 5 December 1977, *Kapala* station K77-23-01; 7 specimens, AM P34159, north-east of Long Reef, New South Wales, dredged, 366 m, 5 December 1977, *Kapala* station K77-23-03; 14 specimens, NMV J7103, north-east of Port Kembla, dredged, 161 m, 13 December 1978, *Kapala* station K78-27-11; 1

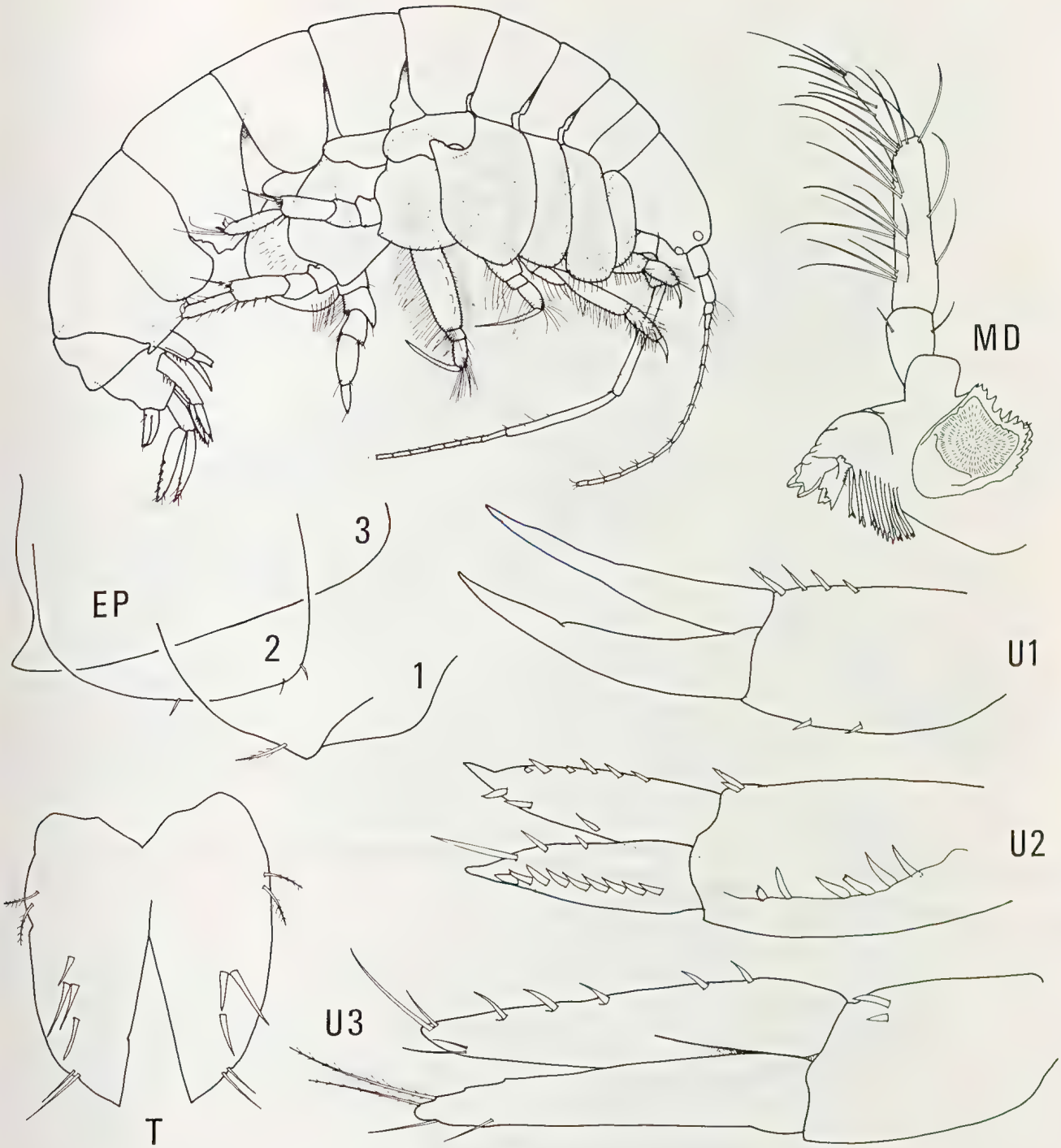

Fig. 5. *Ampelisca ballina* n.sp., holotype, male, l4.4 mm, east of Malabar, New South Wales.

specimen, NMV J7743, eastern Bass Strait, dredged, 293 m, 28 March 1979, BSS station 36.

Diagnosis. Head slightly deeper than long, with small rostrum; anteroventral corner broadly rounded; eyes absent. Antenna 1 nearly as long as peduncle of antenna 2; peduncular article 2 slightly shorter than article 1. Antenna 2 less than half length of body. Coxae 1–3 with rounded posteroventral corners. Peraeopod 4 with article 4, 2.3 times as long as wide. Peraeopod 7, posteroventral margin of article 2 broadly rounded, lined with plumose setae along distal half, distal corner rounded, not extending to distal margin of article 3; article 3 nearly 1.4 times as long as article 4; article 4 with a small anterior lobe; articles 5 and 6 subequal in length and article 6 not inflated. Epimeron 1 with broadly rounded posteroventral corner. Epimera 2 and 3 with posteroventral corners nearly forming right angles. Urosomite 1 with dorsal margin produced

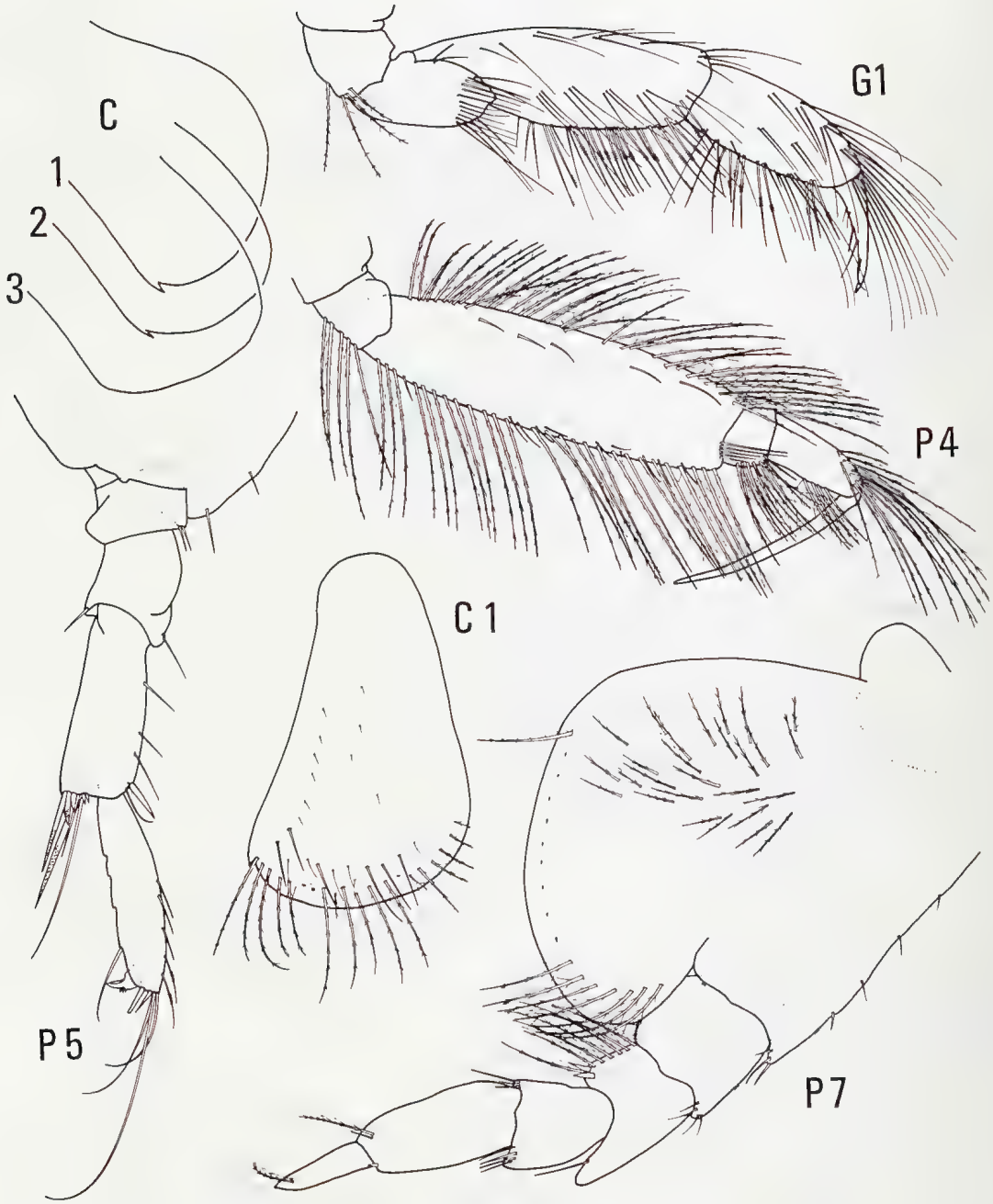

Fig. 6. *Ampelisca ballina* n.sp., holotype, male, 14.4 mm, east of Malabar, New South Wales.

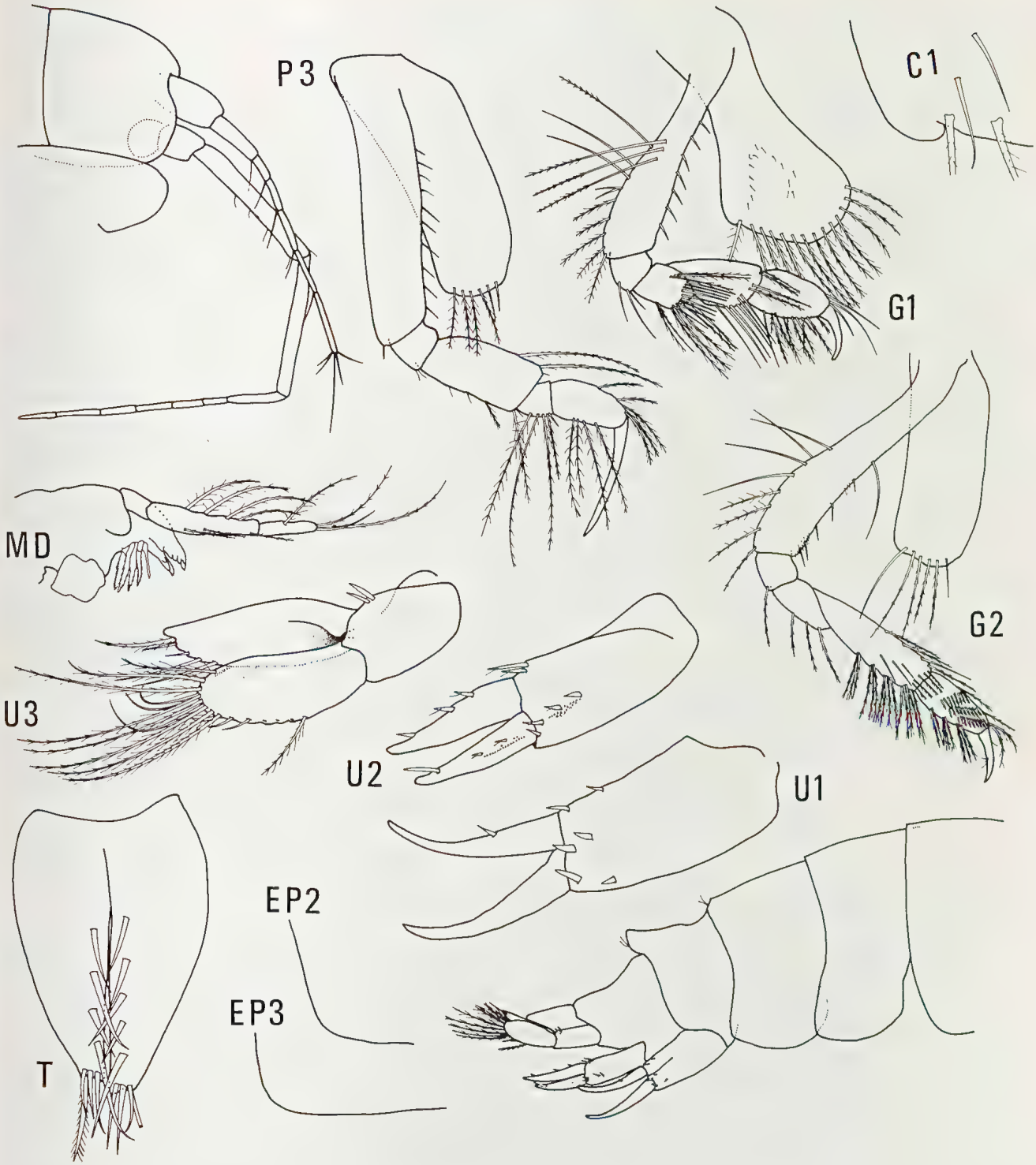

Fig. 7. *Ampelisca bidura* n.sp., holotype, 4.4 mm, east of Bondi, New South Wales.

posteriorly into a large triangular carina. Uropod 2, rami with few dorsal spines, the outer ramus with a long subterminal spine. Uropod 3, inner ramus slightly longer than outer ramus, with distal plumose setae along inner margin; outer ramus apically rounded, with plumose setae extending distally from midpoint of outer margin. Telson about 1.4 times as long as broad, cleft 0.9 times length, with a strong row of spines along margin of cleft and 4 apical spines on each lobe.

Remarks. *Ampelisca bidura* is not similar to any of the known Australian species. It is more closely related to a group of North Pacific species which are characterized by: short head; peraeopod 7 with short posteroventral lobe on article 2 and simple articles 3 to 5 without well-developed lobes; uropod 3 with broad rami, inner ramus rounded apically; urosomite 1 with

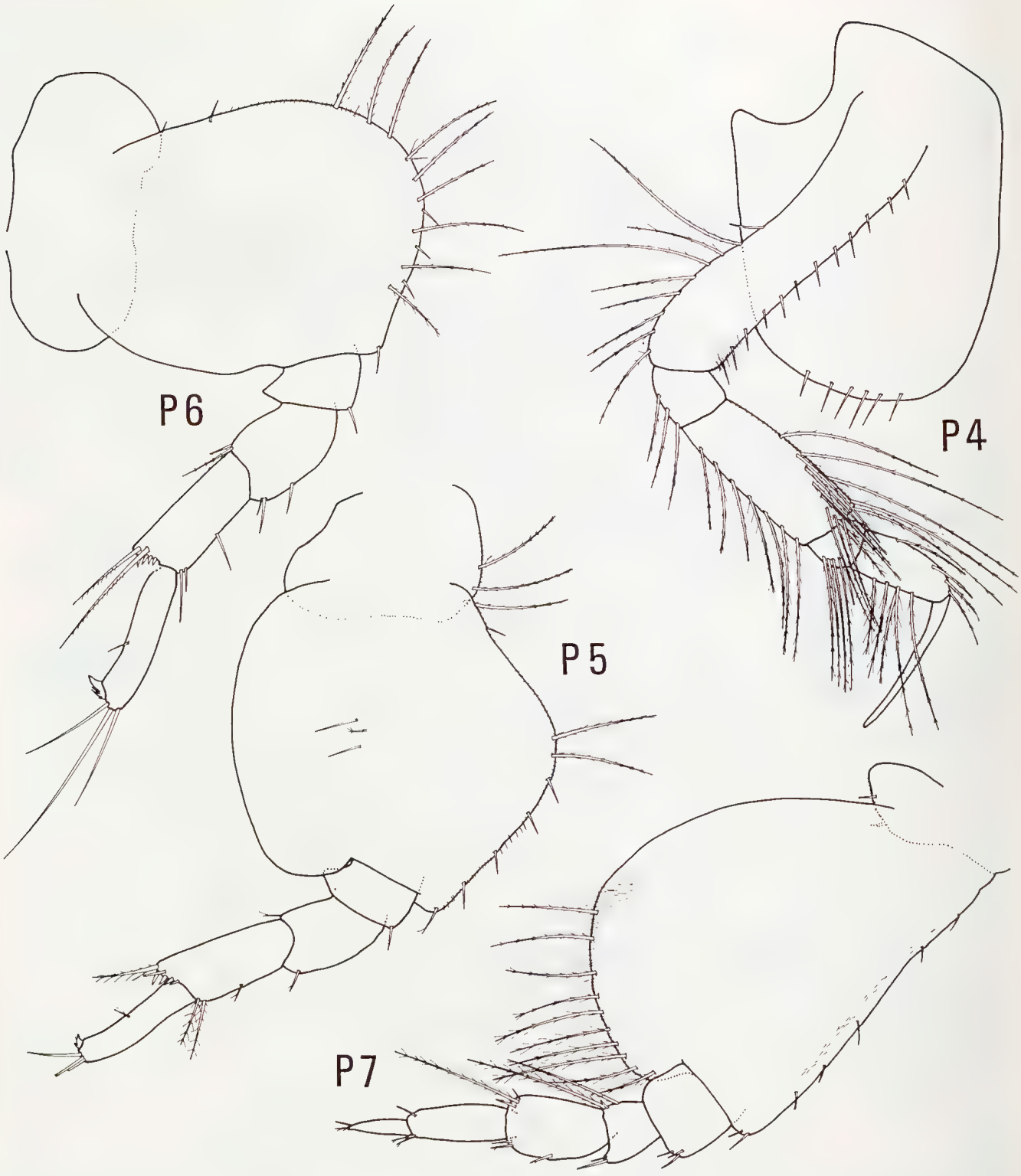

Fig. 8. *Ampelisca bidura* n.sp., holotype, 4.4 mm, east of Bondi, New South Wales.

the distal margin produced into a triangular carina; and a telson with a row of setae or spines along margins of cleft.

Dickinson (1982) recognized this species group and included *A. plumosa* Holmes, *A. birulai* Brüggen and *A. hessleri* Dickinson. We also recognize *A. misakiensis* Dahl, from the Sagami Sea as a member of this group. Imbach (1967) reported *A. misakiensis* from the Bay of Nha-Trang in the South China Sea, but from her illustrations and remarks we think she was describing at least one unknown species. Her illustrations of a large female differ from Dahl's (1945) illustrations in having a shorter antenna 1, a large rostrum on the head, a simple first gnathopod, more strongly produced posterodistal corners on article 4 of peraeopods 5 and 6, a shorter stouter fourth article on peraeopod 7 and a rounded posteroventral corner on epimeron 3.

Within this group, *A. bidura* appears to be most closely related to *A. hessleri*. Both species have similar head shapes, similar first gnathopods and similar telsons. *Ampelisca bidura* differs from *A. hessleri* in lacking eyes, in having shorter first antennae and in having a subapical spine on the outer ramus of uropod 2. It differs from *A. plumosa* in the shape of the head, in having a more oblique palm on gnathopod 1, in having stouter setae on the telson and shorter, broader rami on uropod 3. *Ampelisca birulai* differs from *A. bidura* in having a subchelate gnathopod 1, longer and thinner rami on uropod 3 and very few setae on the telson. *Ampelisca misakiensis*, which appears to be closely related to *A. birulai*, is distinguished from *A. bidura* by its subchelate first gnathopods and the elongate fourth article of peraeopod 7. The *A. misakiensis* of Imbach (1967) is easily distinguished from *A. bidura* by its long cephalic rostrum.

Distribution. New South Wales, Bass Strait; shelf and slope, 80-1200 m.

Ampelisca calooma n.sp.

Figs 9, 10

Type-material. HOLOTYPE: 13.2 mm, AM P34169 (with 4 slides), north-east of Long Reef, New South Wales, 33°43'S 151°40'E, dredged, 143 m, 5 December 1978, *Kapala* station K78-26-02. PARATYPES: 2 specimens, AM P34170, 1 specimen NMV J7104, type-locality; 1 specimen, AM P34171, north-east of Port Kembla, New South Wales, 34°20'S 151°18'E, dredged, 161 m, 13 December 1978, *Kapala* station K78-27-11; 1 specimen, AM P34172, north-east of Long Reef, New South Wales, 33°41'S 151°53'E, dredged, 366 m, 5 December 1977, *Kapala* station K77-23-03; 1 specimen, AM P34130, east of Long Reef, New South Wales, dredged, 176 m, 5 December 1977, *Kapala* station K77-23-01.

Additional material. 1 specimen, NMV J7740, eastern Bass Strait, 140 m, 15 November 1981, BSS station 170.

Diagnosis. Head about 1.2 times as long as deep, without a rostrum; anteroventral corner square, anteroventral margin oblique; 2 pairs of eyes, each with a cuticular lens. Antenna 1 much longer than peduncle of antenna 2, almost as long as antenna 2; peduncular article 2 about 1.7 times as long as article 1. Antenna 2 about two-thirds as long as body. Coxae 1–3 with posteroventral hooks. Peraeopod 4 with article 4, 3.3 times as long as broad. Peraeopod 7, distal lobe of article 2 reaching about midway along article 4, posteroventral margin of article 2 continuously convex, setose ventrally; article 3 about 1.5 times as long as article 4; article 4 with an acute anterodistal lobe; article 5 with an anterior lobe; article 6 only slightly inflated, about 1.8 times as long as broad, as long as articles 4 and 5 combined. Epimera 1 and 2 with rounded posteroventral corner; epimeron 3 with a square posteroventral corner. Urosomite 1 with a broad dorsal rounded keel; urosomites 2–3 without dorsal keel. Uropod 2, rami each with 2 dorsal spine rows; outer ramus with a long subterminal spine. Uropod 3, rami subequal in length, narrow-lanceolate; outer ramus with row of spines on outer margin and setae on inner margin; inner ramus with plumose setae distally. Telson 1.2 times as long as wide, cleft three-quarters of length; lateral margins convex and tapering from base to a subacute apex; setae marginally and 2 pairs dorsally, no spines.

Remarks. Among the species in south-eastern Australia, *Ampelisca calooma* appears to be most closely related to *A. jingera*. It can be easily distinguished from *A. jingera* by its subequal antennae, well-developed anterodistal lobe on article 4 of peraeopod 7 and the lack of a posteroventral hook on epimeron 3.

Distribution. New South Wales and Bass Strait; shelf, 140–366 m.

Ampelisca dimboola n.sp.

Figs 11, 12

Type-material. HOLOTYPE: female, 10.0 mm, AM P23172, 1.5 km east of Burwood Beach, New South Wales, 32°57.5'S 151°44.7'E, fine sand, 22 m, 20 September 1975, HDWBS station 02. PARATYPES: 4 specimens, AM P23166, P23170, P23173, P23174, type-locality, 20-28 m, 18 December 1975, HDWBS stations 01, 02.

Additional material. 8 specimens, AM P22674, P22676, P22678, east of Malabar, New South Wales, 31–53 m, sand, 17–19 May 1972, AMSBS stations; 2 specimens, AM P34127, P34128, Pittwater, New South Wales, 4 m, sand, 30 March 1977; 1 specimen, AM P34205, off Moona Moona Creek, Jervis Bay, New South Wales, 8 m, P.B. and P.M. Berents, 21 February 1982; 1 specimen, NMV J7707, Ninety-mile Beach, Victoria, 16 m, sand, 31 July 1983, BSS station 212; 4 specimens, NMV J7115 and J7116, off Seaspray, Victoria, 10 m, J.E. Watson, 1979.

Diagnosis. Head about 1.4 times as long as deep, without a rostrum; anteroventral margin oblique; 2 pairs of eyes, each with a cuticular lens. Antenna 1 shorter than peduncle of antenna 2; peduncular article 2 about 1.3 times as long as article 1. Antenna 2 up to two-thirds as long as body. Coxae 1–3 with well-developed

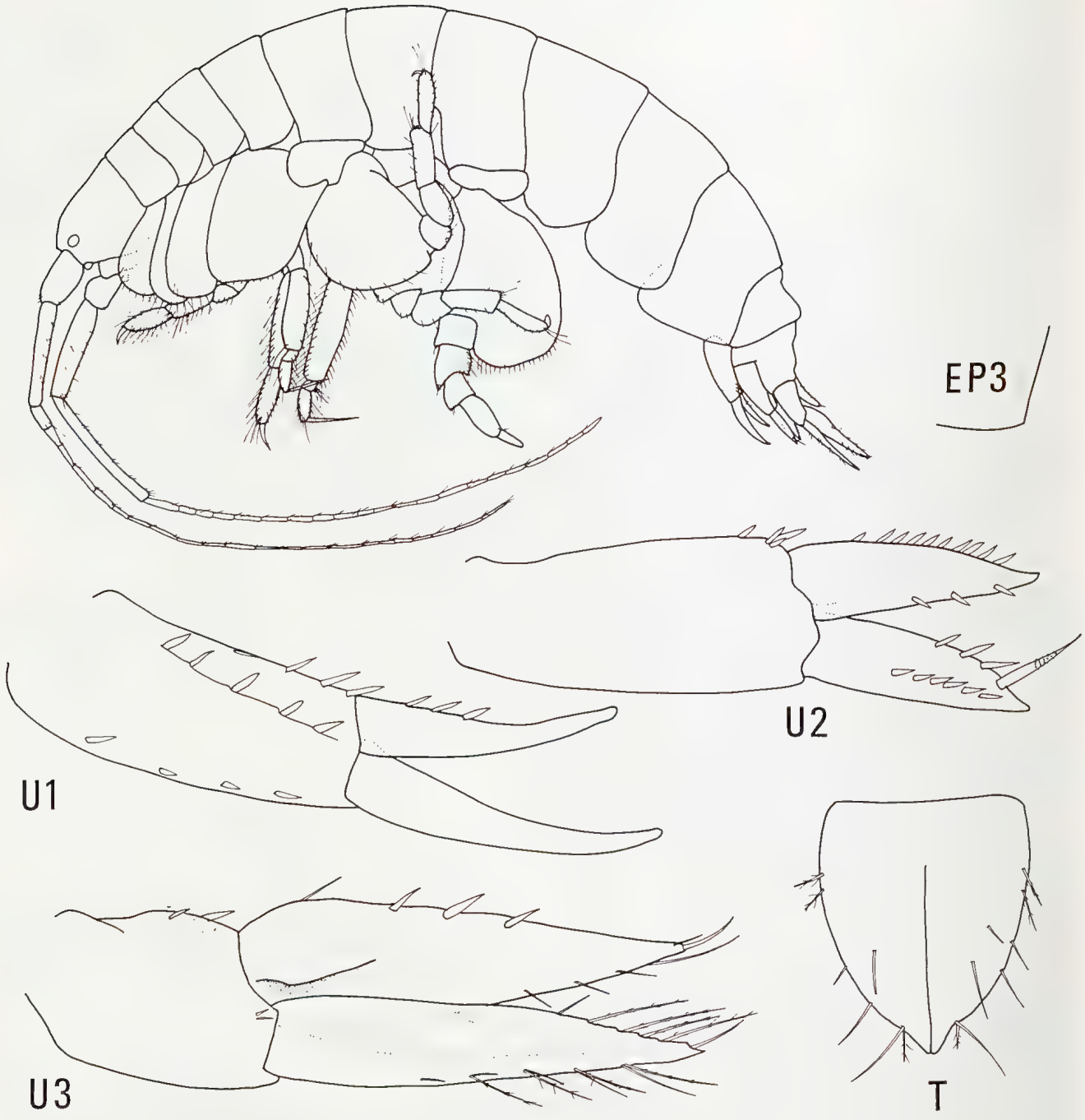

Fig. 9. *Ampelisca calooma* n.sp., holotype, l3.2 mm, north-east of Long Reef, New South Wales.

posteroventral hooks. Peraeopod 4 with article 4 about 3 times as long as broad. Peraeopod 7, article 2 with posteroventral corner rounded, ventral margin transverse, setose, distal corner sharply rounded, reaching midway along posterior margin of article 3; article 4 half length of articles 3 and 5; anterior lobe of article 5 well developed; article 6 inflated, about 1.7 times as long as broad and nearly 1.7 times as long as articles 4 and 5 combined. Epimeron 3, posteroventral corner with shallow sinus and acutely projecting tooth. Urosomite 1 with a dorsal keel, obliquely truncated posteriorly. Uropod 2, inner ramus with long and short spines, outer ramus with short spines and a strong subterminal spine. Uropod 3, rami subequal in length, broadly lanceolate; inner ramus with long plumose setae along inner distal margin; outer ramus with long plumose setae along inner distal margin, outer margin with a row of short spines and plumose setae and a narrow strip of minute denticles distolaterally. Telson 1.5 times as long as broad, cleft 0.6 times length, with a row of mid-dorsal setae and a pair of subapical setae on each lobe.

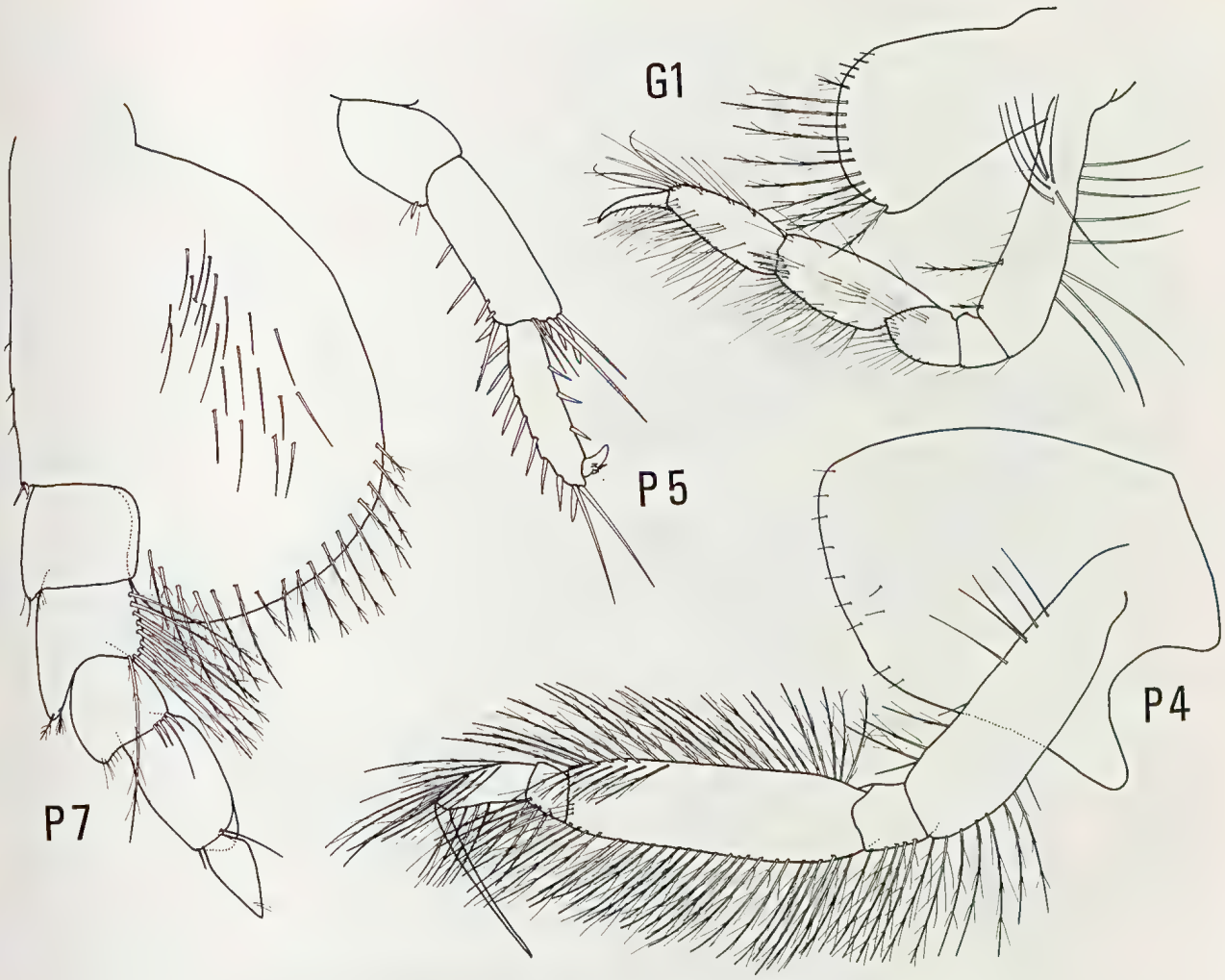

Fig. 10. *Ampelisca calooma* n.sp., holotype, 13.2 mm, north-east of Long Reef, New South Wales.

Remarks. *Ampelisca dimboola* is part of the species group discussed under *A. australis*. It is easily distinguished from *A. australis* by the long and short spine row on the inner ramus of uropod 2. It is distinguished from *A. tilpa* and *A. yuleba* by the very short first antennae.

Distribution. New South Wales, eastern Victoria; bays and inner shelf, 4–53 m.

Ampelisca euroa n.sp.

Figs 13, 14

Ampelisca aequicornis. — Poore *et al.*, 1975: 33, 65.

Type-material. HOLOTYPE: female, 9.0 mm, NMV J2133 (with 3 slides), Port Phillip Bay, Victoria, 38°02.3'S 144°34.5'E, silty sand, 6 m, 18 November 1971, PPBES Station 919. PARATYPES: 11 specimens, AM P34173, Port Phillip Bay, Victoria, 37°53.0'S 144°51.5'E, sand, 8 m, 7 June 1971, PPBES station 901; 1 specimen, AM P34174, Port Phillip Bay, Victoria, 37°55.3'S 144°49.8'E, sand, 9 m, 7 June 1971, PPBES station 904; 3 specimens, AM P34175, Port Phillip Bay, Victoria, 38°04.7'S 144°32.7'E, sand, 7 m, 11 June 1971, PPBES station 929; 4 specimens, NMV J2134, Port Phillip Bay, Victoria, 37°57'S 144°45'E, sand, 5 m, 3 February 1972, PPBES station 907; 8 specimens, NMV J2135, Port Phillip Bay, Victoria, 37°57'S 144°48'E, sand, 9 m, 8 June 1971, PPBES station 908; 2 specimens, NMV J2136, 38°03'S 144°35'E, sand, silt, clay, 6 m, 18 November 1971, PPBES station 919; 2 specimens, NMV J2137, 38°07'S 144°31'E, silt, clay, 7 m, 12 February 1970, PPBES station 942.

Additional material. 3 specimens, AMP34177, P34178, P34184, Port Stephens, New South Wales, 3–22 m, W. Ponder and J. Hall, 25–28 October 1980; 58 specimens, AM P34180, P34181, Box Head, Broken Bay, New South Wales, sponges, 15 m, J.K. Lowry and R.T. Springthorpe, 22 November 1982; 326 specimens, AM P34187 to P34200, Brooklyn, Hawkesbury River, New South Wales, sand and mud, 2–9 m, August 1979 — August 1980; 12 specimens, AM P34201 to P34204, Hawkesbury River, New South Wales, AMHRS stations; 5 specimens, AM P34153, east of Long Reef, New South Wales, dredged, 176 m, 5 December 1977, *Kapala* station K77-23-01; 3 specimens, AM P34183, east of Bondi, New South Wales, dredged, 80 m, R. Springthorpe, 11 December 1980, *Kapala* station K80-20-11; 22 specimens, AM P22661 to P22665, east of Turrametta Heads, Dee Why and Long Reef, New South Wales, 15–38 m, AMSBS stations; 39 specimens, AM P22667 to P22670, P22677 and P34176, east

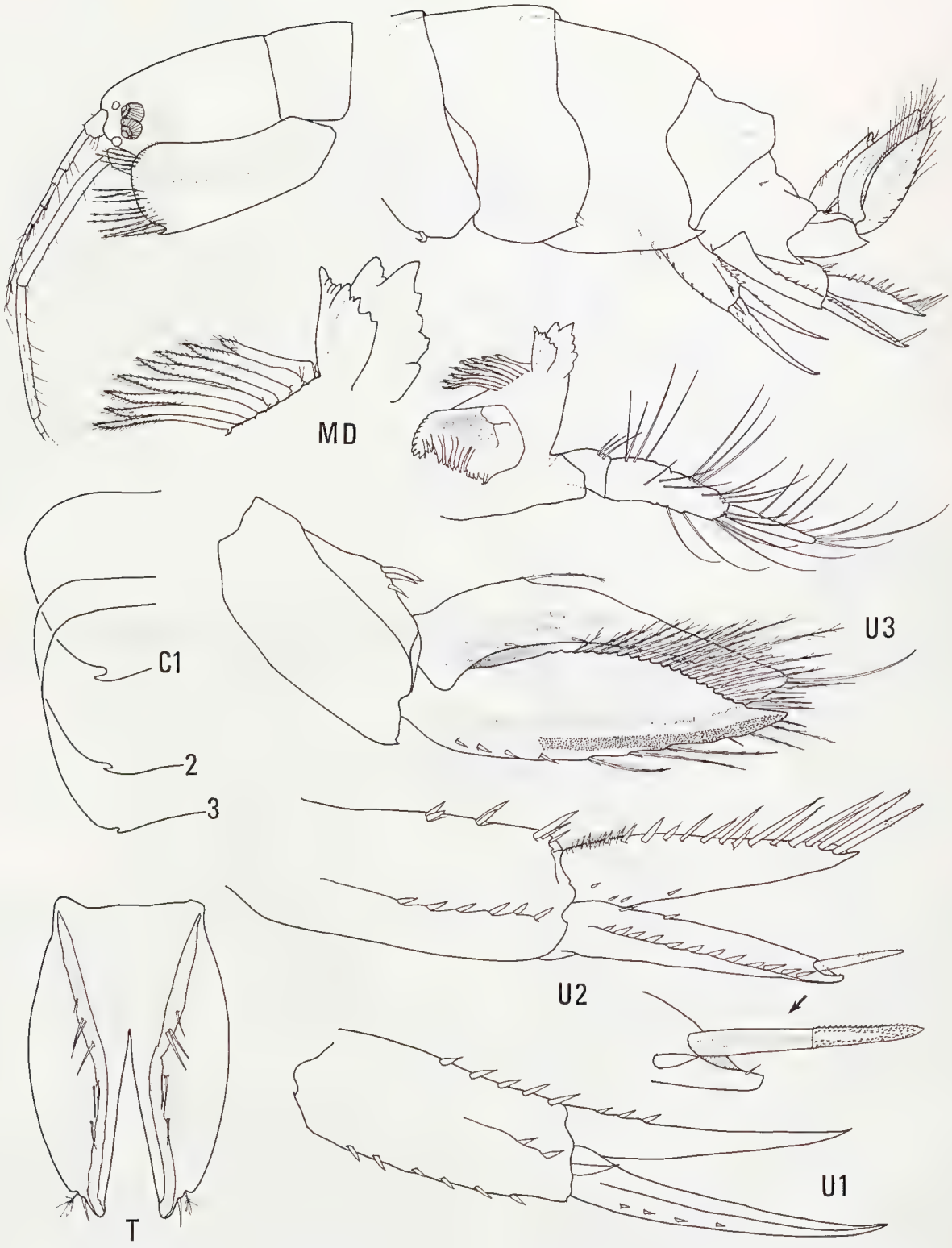

Fig. 11. *Ampelisca dimboola* n.sp., holotype, female, 10.0 mm, 1.5 km east of Burwood Beach, New South Wales.

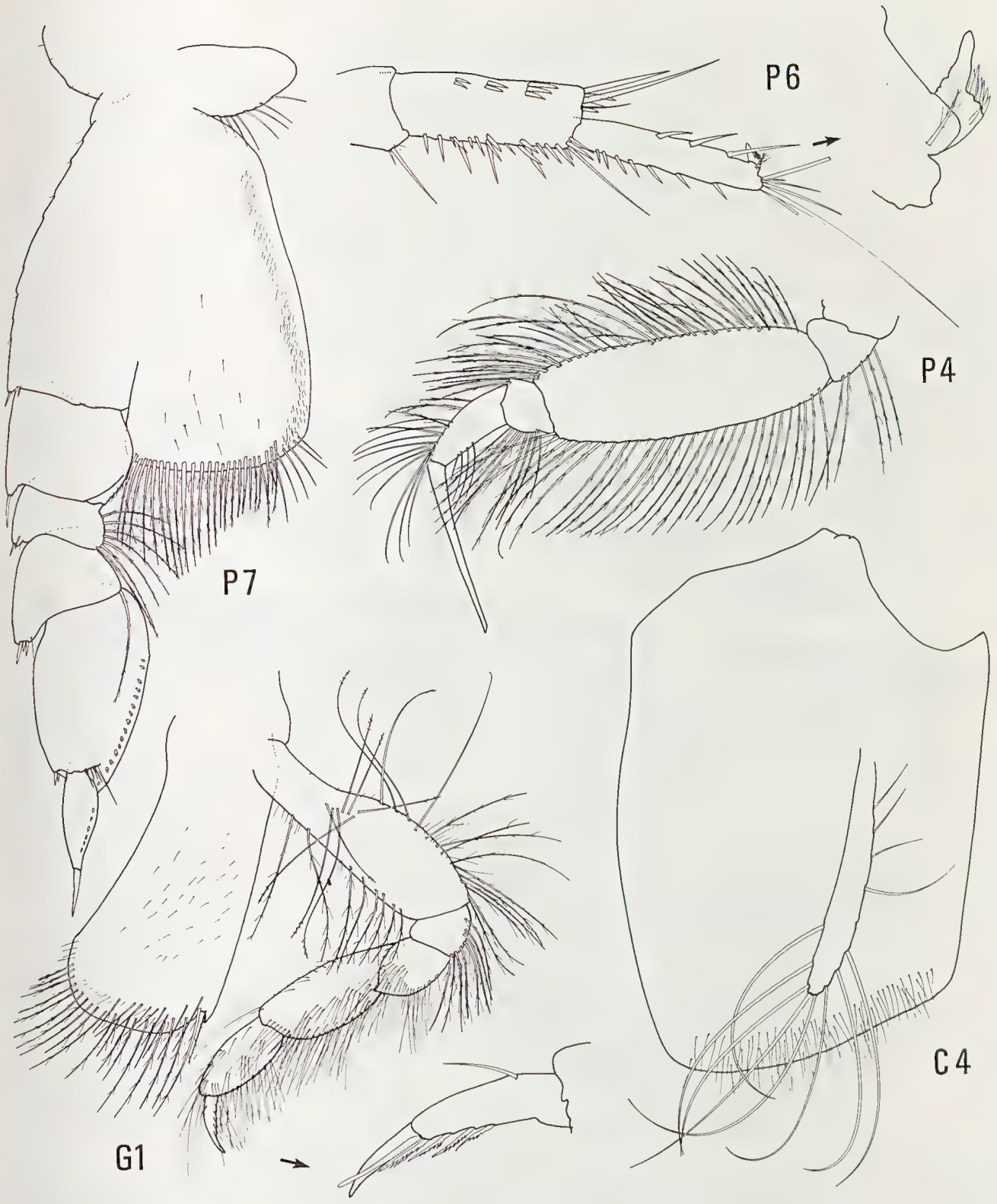

Fig. 12. *Ampelisca dimboola* n.sp., holotype, female, 10.0 mm, 1.5 km east of Burwood Beach, New South Wales.

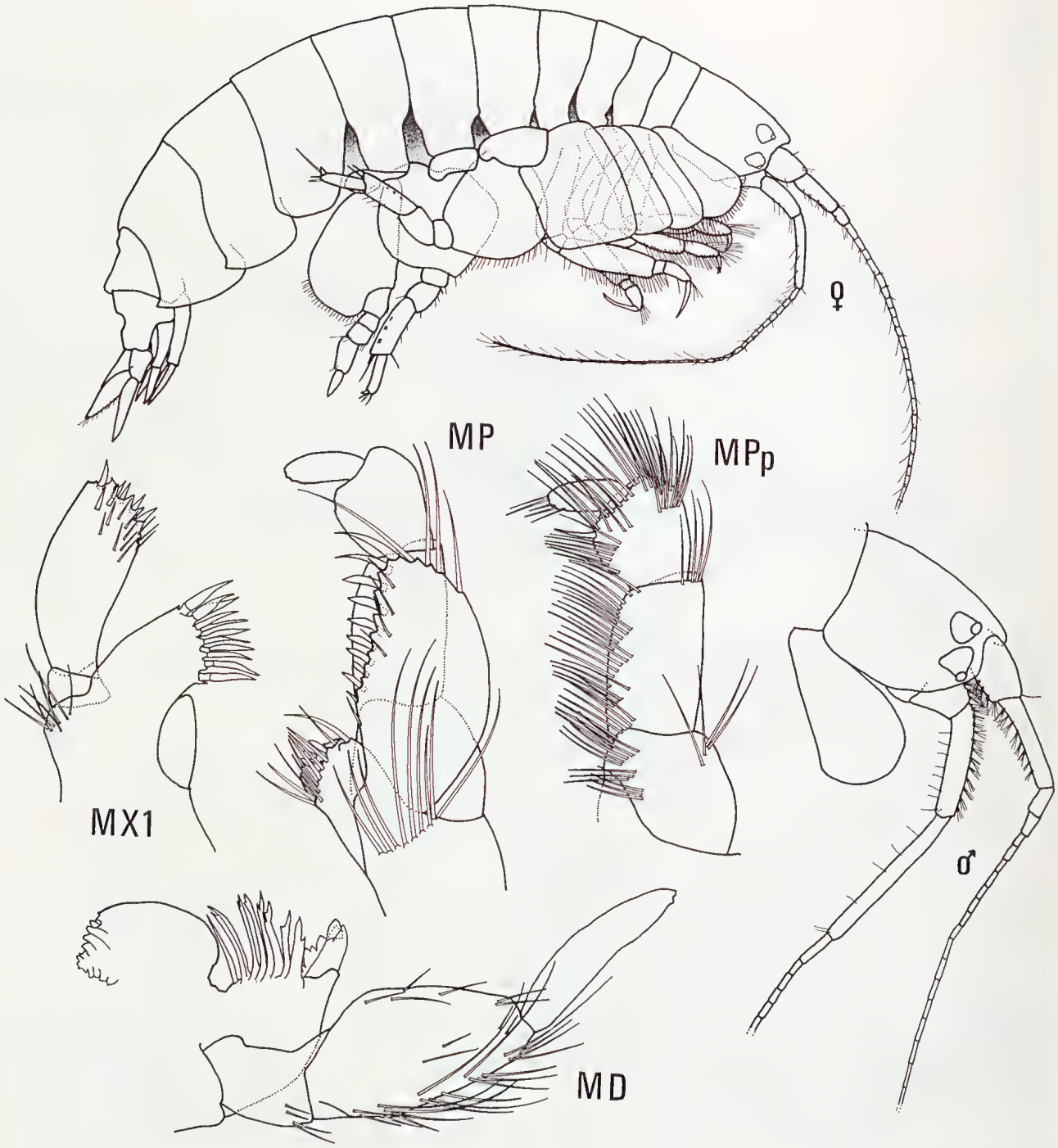

Fig. 13. *Ampelisca euroa* n.sp., holotype, female, 9.0 mm, paratype, male, Port Phillip Bay, Victoria.

of Malabar, New South Wales, 66–81 m, AMSBS stations; 3 specimens, AM P26869 to P26871, Botany Bay, New South Wales, sand, 7–19 m, SPCC stations; 2 specimens, AM P34166, P34167, off Moona Moona Creek, Jervis Bay, New South Wales, on solitary ascidians in *Ecklonia* bed, 3–4.5 m, P. Berents, October 1981; 6 specimens, AM P34179, off Moona Moona Creek, Jervis Bay, New South Wales, mussels, algae and sand, 8 m, J.K. Lowry, 19 June 1982; 60 specimens, AM P34185 and NMV J2138 to J2144, Port Phillip Bay, Victoria, PPBES stations; 950+ specimens, NMV J2786 to J2896, Crib Point, Western Port, Victoria, CPBS stations; 35 specimens, NMV J2145 to J2155, Western Port, Victoria, WBES stations; 40+ specimens, AM P34186, NMV J2156 to J2158, and J7728 to J7736, throughout Bass Strait, BSS stations; 3 specimens, NMV J7737 to J7739, Cape Paterson, Victoria, epifauna; 8 specimens, AM P34164, near Lowly Point, Spencer Gulf, South Australia, 18 m, K. Sheard, 7 March 1938; 1 specimen, AM P34182, Maston old wharf, American River Inlet, Kangaroo Island, South Australia, on *Zostera*, P. Hutchings, 2 March 1979.

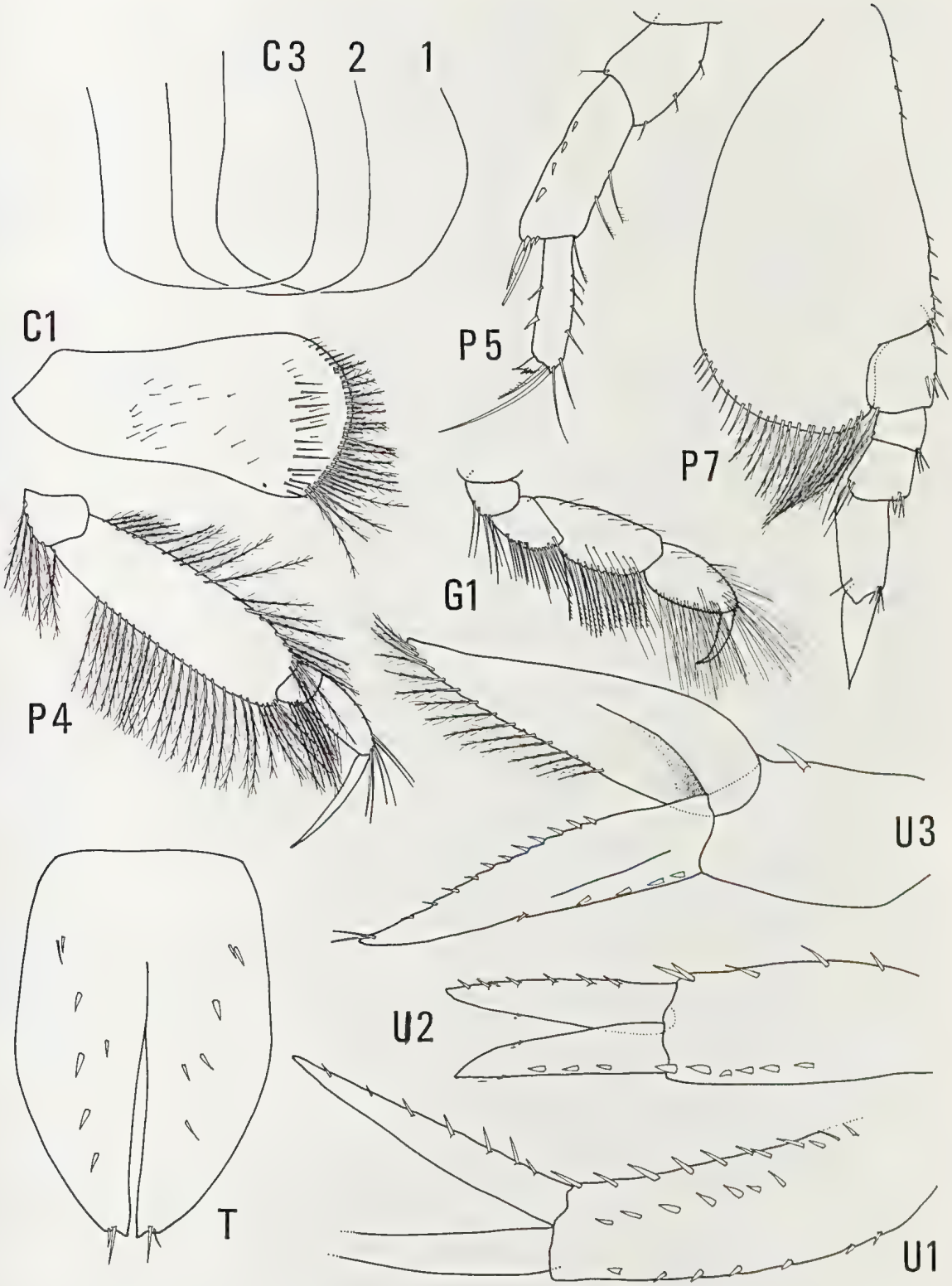

Fig. 14. *Ampelisca euroa* n.sp., holotype, female, 9.0 mm, Port Phillip Bay, Victoria.

Diagnosis. Head about 1.3 times as long as deep, with short rostrum and oblique anteroventral margin; 2 pairs of eyes, each with a cuticular lens. Antenna 1 almost as long as antenna 2; peduncular article 2, 1.3 times as long as article 1. Antenna 2 at least half as long as body. Coxae 1–3 without posteroventral hooks. Peraeopod 4, article 4 about 2.8 times as long as broad. Peraeopod 7, posterior margin of article 2 gently rounded, ventral margin transverse, straight, lined with plumose setae, extending two-thirds along article 3; article 3 twice length of article 4; articles 4 and 5 without anterior or posterior lobes and subequal in length; article 6 not inflated, about twice as long as broad and subequal in length to articles 4 and 5 combined. Epimeron 1 with posteroventral corner rounded. Epimera 2 and 3, posteroventral corners each with acutely projecting tooth. Urosomite 1 with a low crest, abruptly cut off posteriorly; urosomites 2–3 with a shallow sinus. Uropod 2, rami subequal, each with a dorsal row of minute spines. Uropod 3, rami lanceolate, subequal in length; inner ramus with short plumose setae along inner margin; outer ramus with short spines along inner and outer margins. Telson 1.5 times as long as broad, cleft 0.7 times length, with a row of short dorsal spines and a pair of short apical setae on each lobe.

Remarks. *Ampelisca euroa* differs from all other *Ampelisca* species in this study in its peculiar mandibular palp with its swollen second article and long, slender third article. However, *A. euroa* does appear to be closely related to *A. milleri* J.L. Barnard from California. Both species have similar mandibular palps, first gnathopods, seventh peraeopods, second and third uropods and telson. *Ampelisca euroa* is distinguished from *A. milleri* by its longer first antennae, different head shape and acute posteroventral corners on epimera 1 and 2. *Ampelisca nossibeensis* Ledoyer also has a similar mandibular palp, first gnathopod, seventh peraeopod and third uropod. But although the second uropod lacks a subapical spine on the inner ramus as in *A. euroa* and *A. milleri*, the rami are long and slender. The telson also differs in having apical spines.

Ampelisca euroa is the most abundant ampeliscid species in south-eastern Australia. It occurs in estuarine conditions and on the continental shelf from as far north as Port Stephens, New South Wales, to the Spencer Gulf in South Australia. In Port Phillip Bay this species prefers sandy rather than muddy substrates where it averages about 50 individuals per square metre (Poore *et al.*, 1975).

Distribution. New South Wales, Victoria, Bass Strait, South Australia; shelf and bays, 3–176 m.

Ampelisca jingera n.sp.

Figs 15, 16

Type-material. HOLOTYPE: 7.5 mm, AM P34135 (with 3 slides), off St Helens Point, Tasmania, 41°20.6'S 148°30'E, fine clayey sand, 110 m, P. Colman, 25 March 1973, BMR station 573-2038. PARATYPES: 3 specimens, AM P34136, 3 specimens, NMV J1563, type-locality.

Additional material. 21 specimens, AM P34134, east of Long Reef, New South Wales, dredged, 175 m, 5 December 1977, *Kapala* station K77-23-01; 2 specimens, AM P34161, north-east of Long Reef, New South Wales, dredged, 143 m, 5 December 1978, *Kapala* station K78-26-02; 1 specimen, AM P34137, east of Bondi, New South Wales, dredged, 80 m, R. Springthorpe, 11 December 1980, *Kapala* station K80-20-11; 1 specimen, AM P34129, Botany Bay, New South Wales, September 1921; 8 specimens, AM P34160, north-east of Wollongong, New South Wales, dredged, 161 m, 13 December 1978, *Kapala* station K78-27-11; 50+ specimens, NMV J7114, J7708 to J7710, J7727, Bass Strait, dredged, 82–293 m, BSS stations 32, 36, 158 and 170.

Diagnosis. Head 1.2 times as long as deep; anteroventral margin oblique and straight; 2 pairs of eyes, each with a cuticular lens. Antenna 1 about 1.5 times length of peduncle of antenna 2; peduncular article 2 a little longer than article 1. Antenna 2 about as long as body. Coxae 1–3 all with posteroventral hooks. Peraeopod 4 with article 4, 3.2 times as long as wide. Peraeopod 7, posterior margin of article 2 convex, widest distally, posteroventral margin gently convex, bearing plumose setae, distal corner rounded and extending about halfway along article 4; article 3 about as long as article 4; articles 4 and 5 each with a triangular anterodistal lobe; article 6 tapering, 2.2 times as long as wide, subequal to articles 4 and 5 together. Epimera 1 and 2 with rounded posteroventral corners; epimeron 3, posteroventral corner with a prominent acute tooth. Urosomite 1 with a small dorsal carina posteriorly. Uropod 2, rami subequal, each with 2 rows of dorsal spines; outer ramus with a long subterminal spine. Uropod 3, rami subequal, narrowly lanceolate; inner ramus with plumose setae along distal halves of both margins; outer ramus acute, with spines on outer margin. Telson 1.3 times as long as broad, cleft 0.7 times length, with 2 dorsal spines and a distal spine and seta on each lobe.

Remarks. *Ampelisca jingera* is most closely related to *A. calooma* as discussed under that species. The species occur together in some samples.

Distribution. New South Wales, Bass Strait and Tasmania; shelf and slope, 80-293 m.

Ampelisca narooma n.sp.

Fig. 17

Type-material. HOLOTYPE: 11.0 mm, AM P34140 (with 3 slides), east of Port Kembla, New South Wales, 34°27-26'S 151°27'E, dredged, *Globigerina* ooze, 1200 m, J.K. Lowry, 13 December 1976, *Kapala* station K76-23-02. PARATYPES: 3 specimens, AM P34141, type-locality.

Additional material. One specimen, AM P27291, east of Lady Elliott Island, Queensland, 24°00'S 153°06'E, worm tubes and pteropod shells in fine grey sandy ooze, 476–531 m, P. Colman and F. Rowe on HMAS *Kimbla*, 17 November 1977.

Diagnosis. Head about 1.4 times as long as deep, without rostrum; anteroventral margin oblique and sinuoid; without eyes. Antenna 1 slightly longer than peduncle of antenna 2; peduncular article 2 about 1.5 times as long as article 1. Antenna 2 about half length

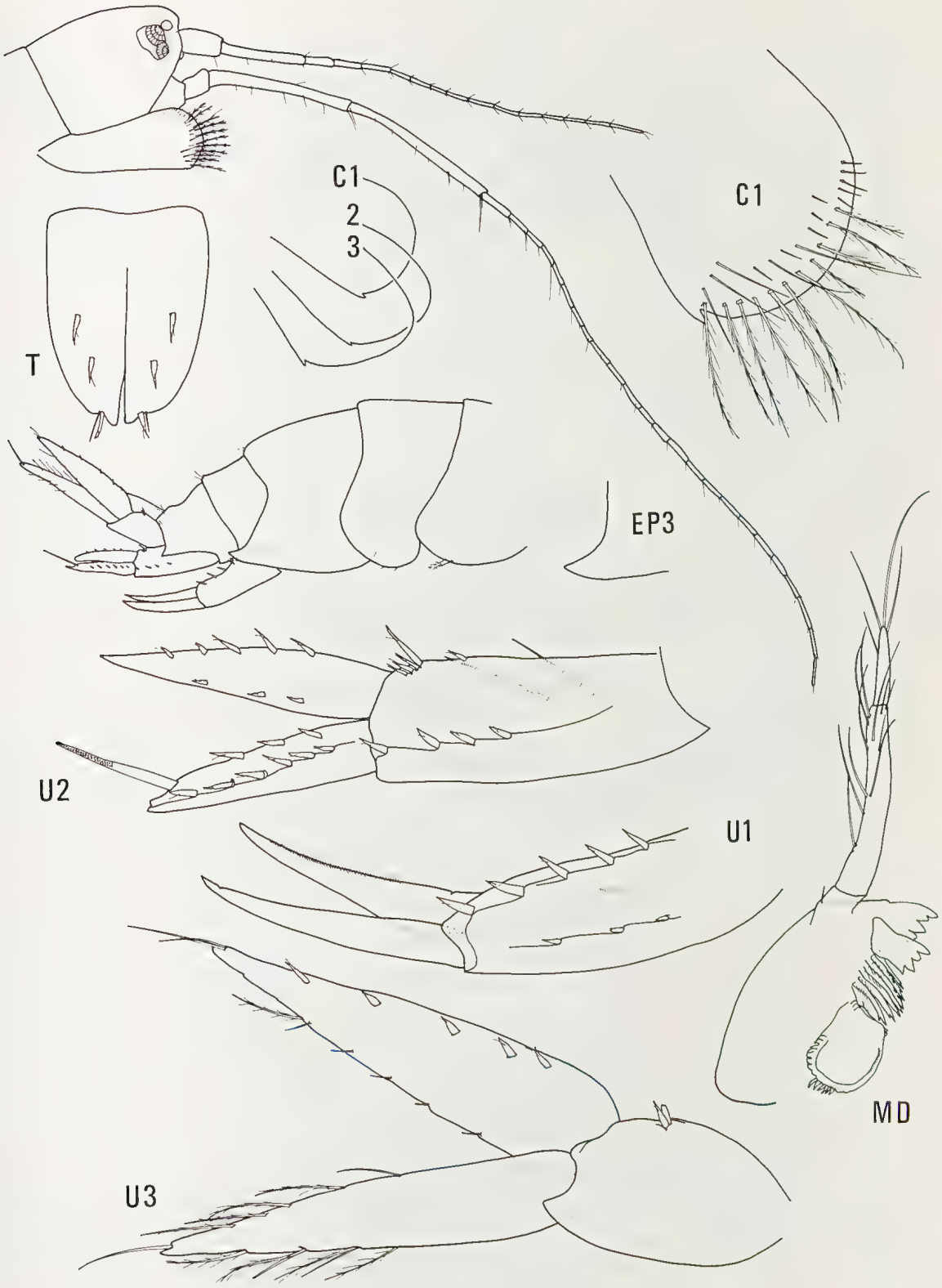

Fig. 15. *Ampelisca jingera* n.sp., holotype, 7.5 mm, off St Helens Point, Tasmania.

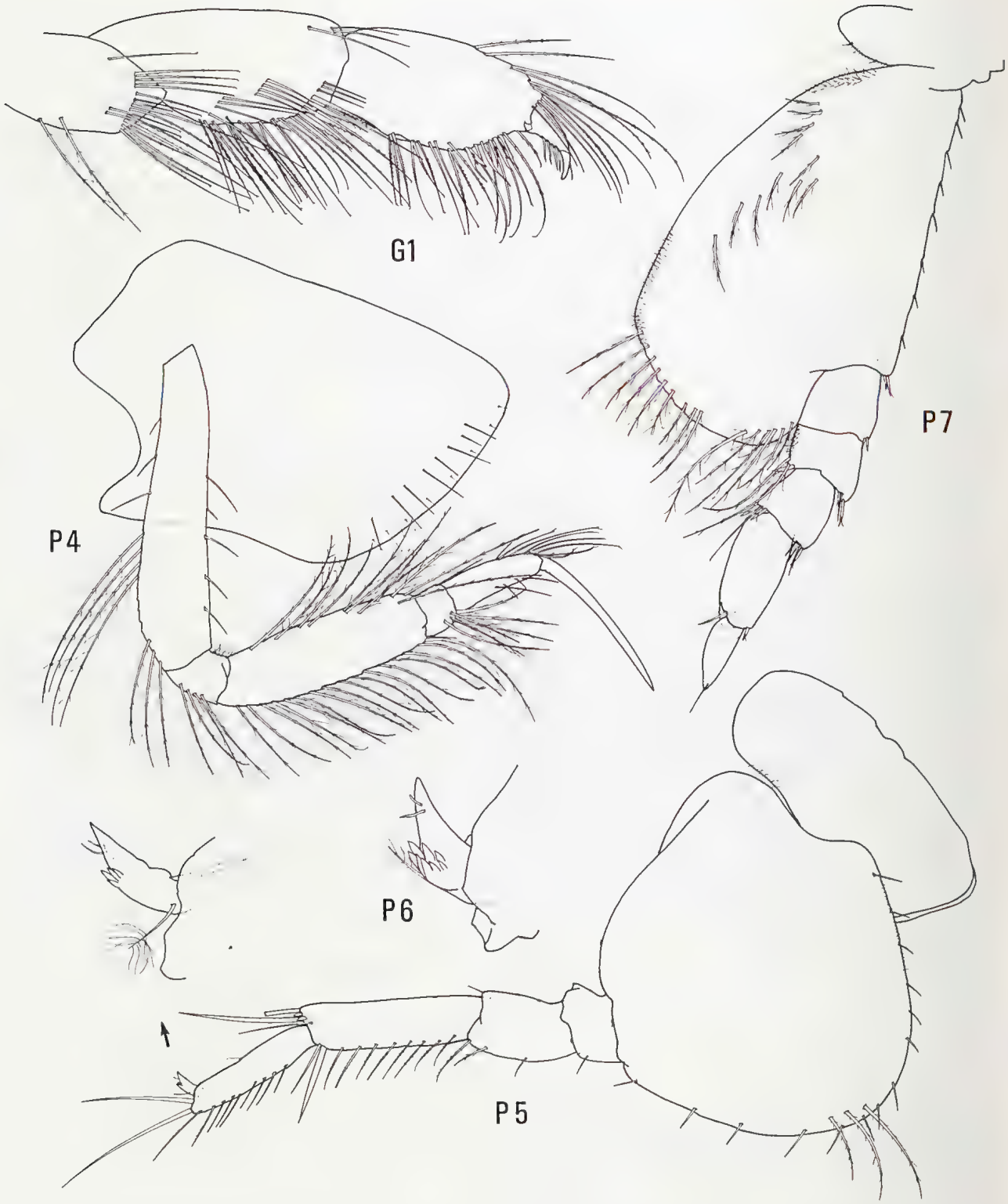

Fig. 16. *Ampelisca jingera* n.sp., holotype, 7.5 mm, off St Helens Point, Tasmania.

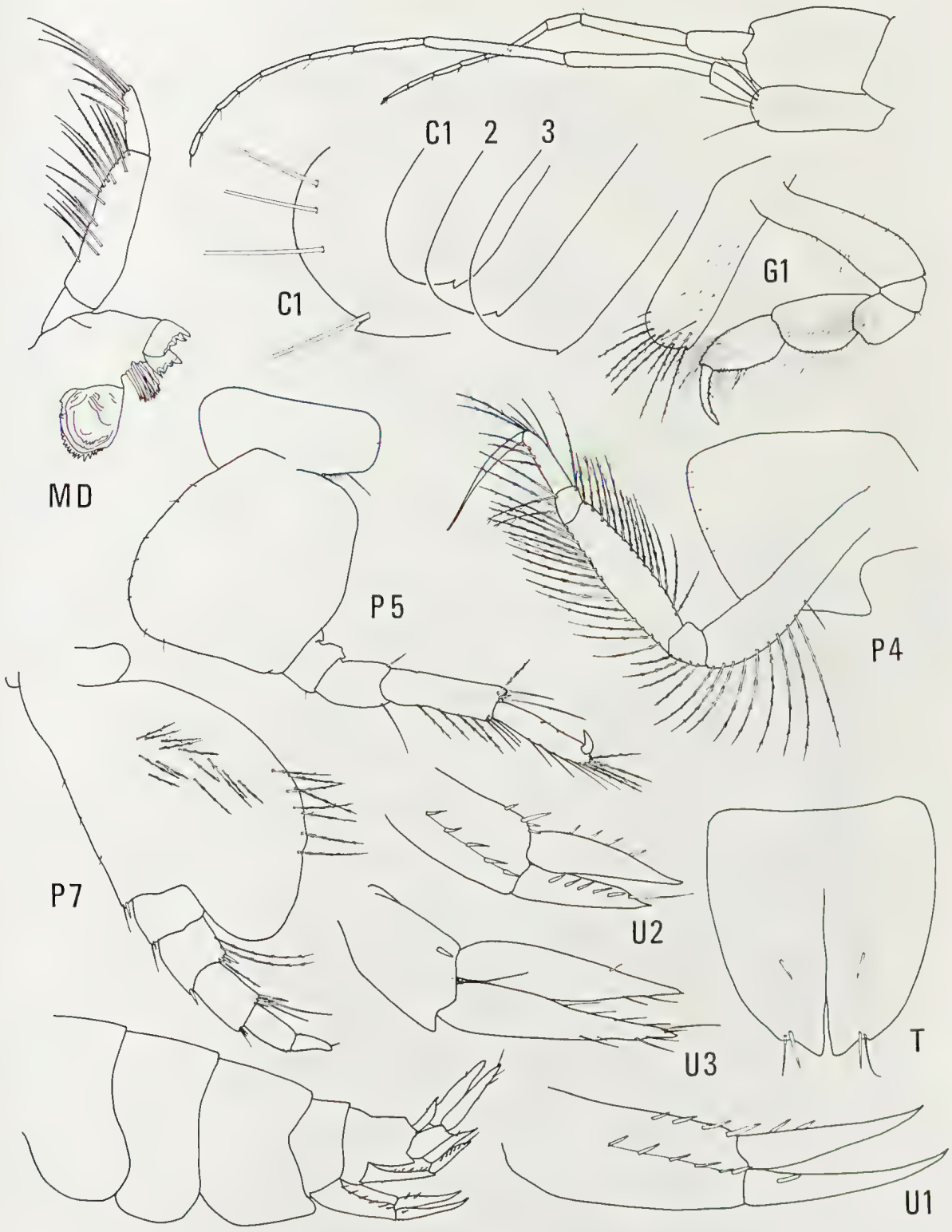

Fig. 17. *Ampelisca narooma* n.sp., holotype, 11.0 mm, east of Port Kembla, New South Wales.

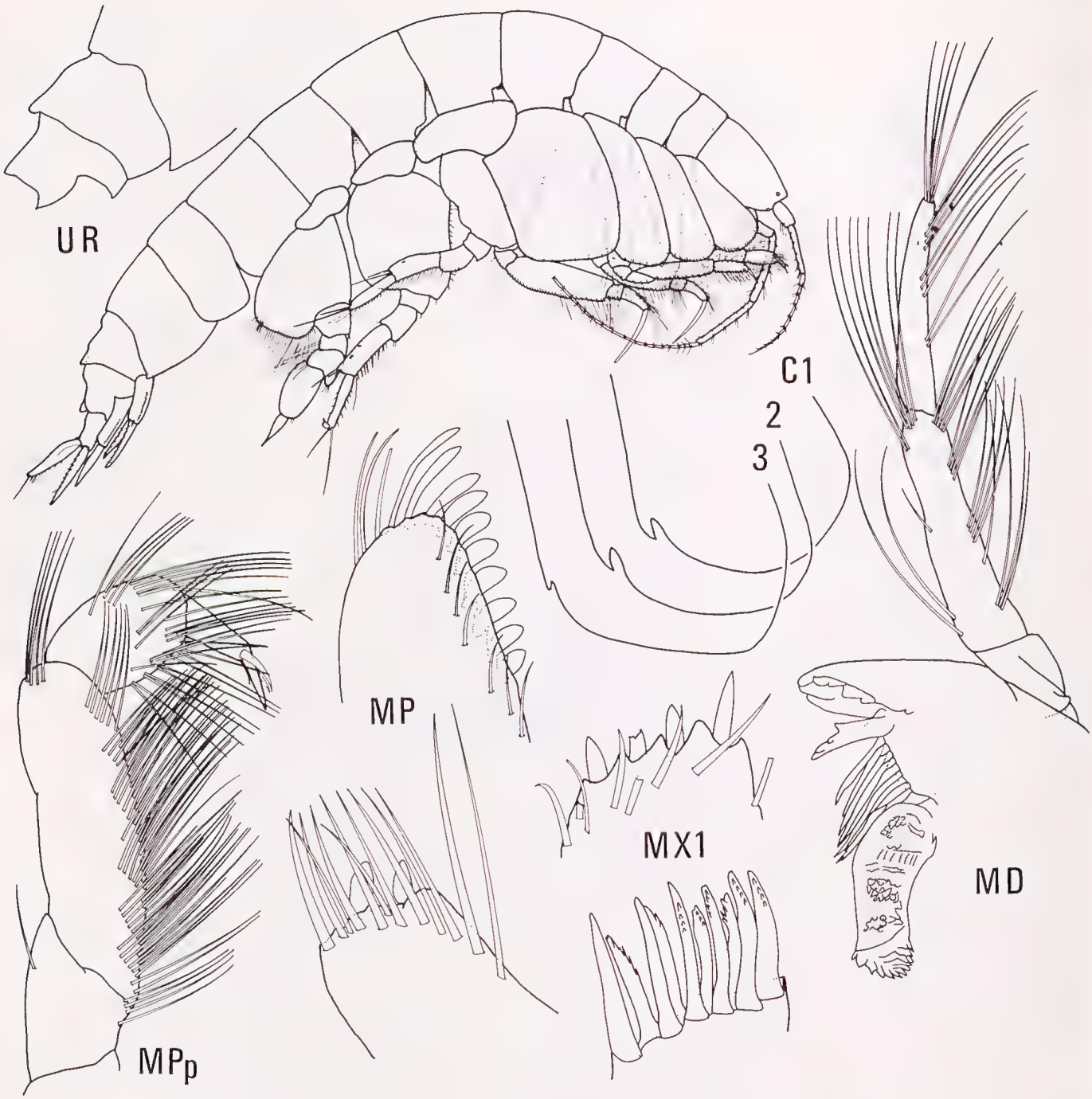

Fig. 18. *Ampelisca tilpa* n.sp., holotype, 13.3 mm, east of Burwood Beach, New South Wales.

of body. Coxae 1–3 with minute posteroventral hooks. Peraeopod 4 with article 4 about 3.5 times as long as broad. Peraeopod 7, posterior margin of article 2 ovate, reaching to distal margin of article 4, with a patch of plumose setae just distal to mid-posterior margin, ventral margin naked; articles 3 and 4 subequal in length; article 6 small, not inflated, about twice as long as broad, 0.8 times length of article 5. Epimera 1 and 2 with posteroventral corners broadly rounded; epimeron 3 with posteroventral corner produced into a subacute tooth. Urosomites without dorsal crests. Uropod 2, rami each with a dorsal spine row; shorter outer ramus with long fine subterminal spine. Uropod 3, rami narrow, subequal in length, lanceolate, with sparse setation. Telson about as long as broad, cleft 0.8 times length, with a mid-dorsal seta and 2 subapical setae on each lobe.

Remarks. *Ampelisca narooma* does not appear to be closely related to any south-eastern Australian species. The slender, lanceolate rami of uropod 3 are similar to those of *A. calooma* and *A. jingera*, but the rami are less setose than in either of those species.

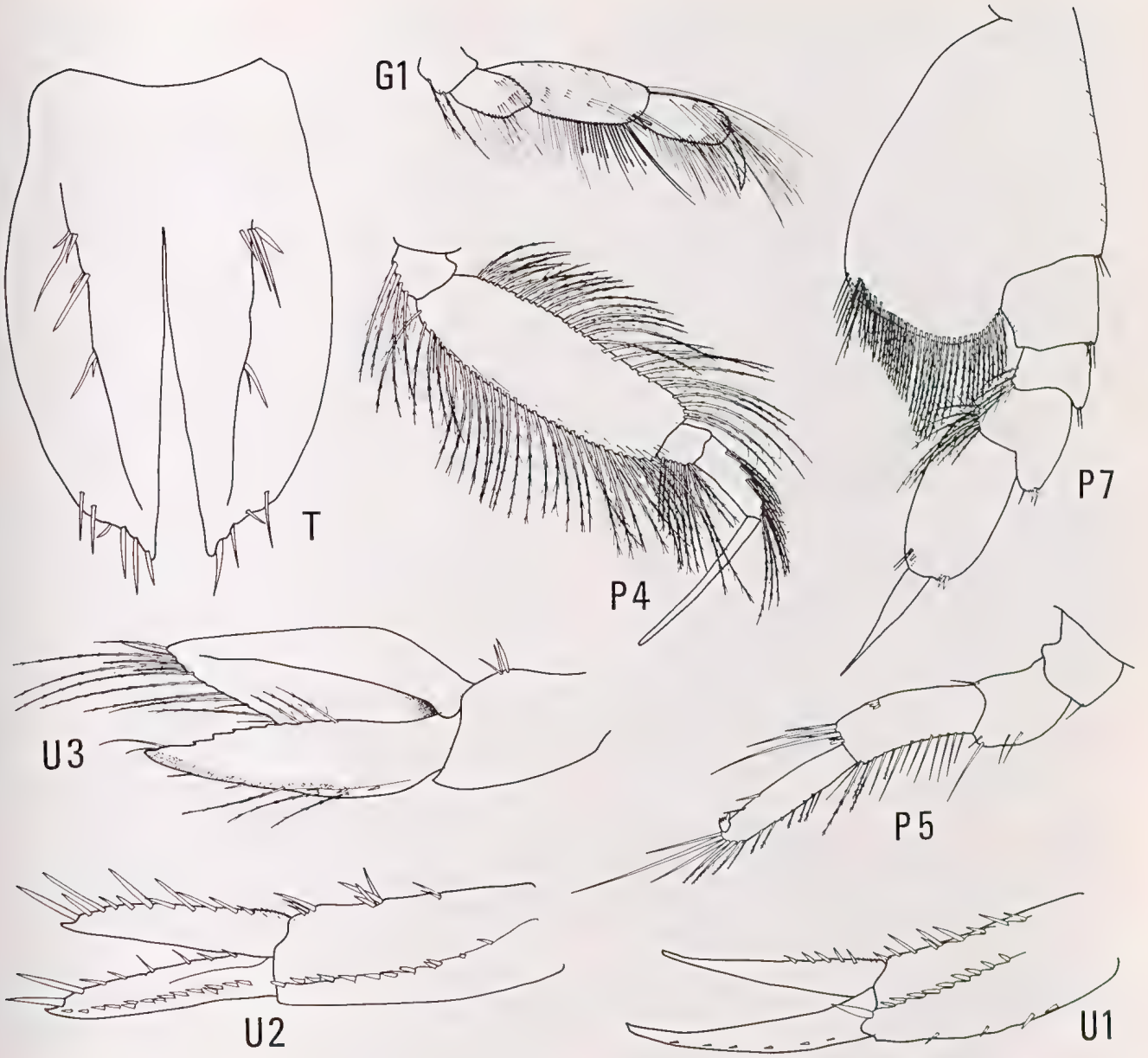

Fig. 19. *Ampelisca tilpa* n.sp., holotype, 13.3 mm, east of Burwood Beach, New South Wales.

Although article 2 of peraeopod 7 is produced along article 4 as in *A. calooma* and *A. jingera*, both of these species have an inflated article 5, and in *A. calooma* article 4 has anterodistal lobes.

Distribution. Queensland, New South Wales; slope, 476-1200 m.

Ampelisca tilpa n.sp.

Figs 18, 19

Ampelisca sp. — Dorsey & Synott, 1980: 159.

Type-material. HOLOTYPE: 13.3 mm, AM P34142 (with 4 slides), 500 m east of Burwood Beach, New South Wales, 32°57.5'S 151°44.7'E, coarse sand, 14 m, Shipek grab, 22 August 1975, HDWBS transect 03. PARATYPES: 6 specimens, AM P23175 to P23179 and NMV J7102, type-locality, 14–26 m, 17 March–18 December 1975, HDWBS transects 01 to 03; 1 specimen, AM P23180, 1 km east of Dudley Beach, New South Wales, 32°58.7'S 151°43.8'E, coarse sand, 15 m, Shipek grab, 30 November 1975, HDWBS transect 02.

Additional material. 74 specimens, NMV J2159 to J2163, Black Rock, Breamlea, Victoria, fine sand, 9–22 m, J. Dorsey, 10 November 1978 to 24 January 1979; 50 specimens, NMV J7106 to J7113, off Seaspray, Victoria, 10 m, J.E. Watson, 1979 and 1980; 15 specimens, AM P27073, P27080, P27095, P27104, Lagoon Bay, Tasmania, sand, 16 m, A.J. Dartnall, 7 June 1977.

Diagnosis. Head 1.5 times as long as deep, without rostrum; anteroventral margin oblique; 2 pairs of eyes, each with a cuticular lens. Antenna 1 about as long as peduncle of antenna 2, peduncular article 2 twice as long as article 1. Antenna 2 about two-thirds length of body. Coxae 1–3 with posteroventral hooks. Peraeopod 4 with article 4, 3 times as long as broad. Peraeopod 7, article 2 with posterior margin oblique, posteroventral margin

sharply rounded, ventral margin oblique, more or less straight and bearing plumose setae, not extending to distal margin of article 3; article 3 twice as long as article 4; articles 4 and 5 with anterior lobes; article 6 inflated, nearly 1.8 times as long as broad and 1.5 times as long as articles 4 and 5 combined. Epimera 1 and 2 with broadly rounded posteroventral corners; epimeron 3, posteroventral corner with subacutely projecting tooth. Urosomite 1 with a low crest projecting posteriorly as a small tubercle. Urosomites 2–3 mid-dorsally simple, but with posterolateral projections. Uropod 2, rami subequal; inner ramus with row of dorsal spines of varying lengths; outer ramus with dorsal spine row plus 2 long subterminal spines. Uropod 3, rami subequal in length, broadly lanceolate; inner ramus with a distal row of plumose setae along outer margin; outer ramus with plumose setae distally along inner margin, outer margin with a row of plumose setae, a row of small spines and a long, narrow patch of minute denticles. Telson 1.5 times as long as broad, cleft 0.7 times length, with a row of strong mid-dorsal setae and a row of about 6 strong apical setae on each lobe.

Remarks. *Ampelisca tilpa* is a member of the species group discussed under *A. australis*. It is very closely related to *A. yuleba*. *Ampelisca tilpa* has shorter second antennae and a longer, more slender, mandibular palp than *A. yuleba*. The posteroventral margin of article 2 of peraeopod 7 does not project beyond article 3 in *A. tilpa*, and uropods 1 and 2 are more spinose. The telson in *A. tilpa* is broader and the mid-dorsal setae are more slender.

Ampelisca tilpa is currently known from south of Newcastle, New South Wales, and *A. yuleba* is known only from Moreton Bay, Queensland. The possibility exists that the populations are clinal variations of one species.

Distribution. New South Wales, Victoria, Tasmania; shelf and bays, 9–26 m.

Ampelisca toora n.sp.

Fig. 20

?*Ampelisca australis*. — Haswell, 1885: 97, pl. 13 figs 1–3 (part from Port Stephens).

Ampelisca sp. 2. — Poore *et al.*, 1975: 33, 65.

Type-material. HOLOTYPE: 11.0 mm, NMV J2165 (with 3 slides), Port Phillip Bay, Victoria, 38°07.0'S 144°44.7'E, sand, 4 m, 16 November 1971, PPBES station 945. PARATYPES: 33 specimens, NMV J2166 and AM P34702, southern Port Phillip Bay, Victoria, 38°21.1'S 144°51.5'E, sand, 9 m, 9 December 1971, PPBES station 985; 1 specimen, NMV J2167, between Hogan Group and East Moncoeur Island, Bass Strait, 39°10.9'S 146°37.2'E, bryozoan sediment, 55 m, B.J. Smith *et al.* on HMAS *Kimbla*, 25 November 1973, station K7/73-53; 1 specimen, NMV J2168, between Wilsons Promontory and Glennie Island, Bass Strait, 39°03.5'S 146°14.4'E, bryozoan sediment, 49 m, B.J. Smith *et al.* on HMAS *Kimbla*, 26 November 1973, station K7/73-60.

Additional material. One specimen, QM W6361, off Fraser Island, Queensland, 25°08'S 153°33'E; 1 specimen, AM P34143, south of Fraser Island, Queensland, 25°48'S 153°46'E, dredged, 73 m, 10 November 1976, *Kimbla* station Q11; 1 specimen, AM P34162, south-east of Port Stephens, New South Wales, dredged, 145 m, 6 December 1978, *Kapala* station K78-26-07; 1 specimen, AM P34156, east of Long Reef, New South Wales, dredged, 176 m, 5 December 1977, *Kapala* station K77-23-01; 50+ specimens, NMV J7698 to J7706, Bass Strait, dredged, 26–82 m, BSS stations; 1 specimen, AM P34163, south of Mount Young, Spencer Gulf, South Australia, 18 m, K. Sheard on FL *Whyalla*, 8 March 1938.

Diagnosis. Head 1.3 times as long as deep, without rostrum; anteroventral corner rounded; 2 pairs of eyes, each with a cuticular lens. Antenna 1 subequal in length to peduncle of antenna 2; peduncular article 2 subequal in length to article 1. Antenna 2 as long as body. Coxae 1 and 2 with shallow posteroventral hooks. Coxa 3 with rounded posteroventral corner. Peraeopod 4, article 4 about twice as long as broad. Peraeopod 7, posterior margin of article 2 slightly rounded, posteroventral margin oblique, slightly concave and lined with plumose setae, distal corner sharp and just overlapping article 4; article 3 subequal in length to article 4; articles 4 and 5 with anterior lobes; article 4 subequal in length to article 5; article 6 inflated, about as broad as long. Epimera 1 and 2 with broadly rounded posteroventral margins; epimeron 3, posteroventral corner with acutely projecting tooth. Urosomite 1, dorsal process strongly saddle-shaped. Uropod 2, rami subequal, each ramus with a dorsal row of short spines, outer ramus with a long, subterminal spine. Uropod 3, rami broadly lanceolate, subequal in length; inner ramus with plumose setae along outer distal margin; outer ramus with short spines and setae, and a long narrow patch of minute denticles along outer margin. Telson 1.3 times as long as wide, cleft 0.8 times length, with a sparse row of mid-dorsal setae and 3 subapical setae on each lobe.

Remarks. *Ampelisca toora* is a member of the species group discussed under *A. australis*. It is distinguished by the saddle-shaped dorsal carina on urosomite 1 and the subtle excavation on the posteroventral margin of article 2 of peraeopod 7.

Haswell (1885) illustrated a specimen from Port Stephens which he called *A. australis*, but which appears to be *A. toora*. This species currently has the widest distribution of any Australian ampeliscid species, from Spencer Gulf, South Australia, to off Fraser Island, Queensland, and its occurrence in Port Stephens is reasonable.

Distribution. Queensland, New South Wales, Victoria, Bass Strait; shelf and bays, 4–176 m.

Ampelisca yuleba n.sp.

Fig. 21

Type-material. HOLOTYPE: female, 10.2 mm, QM W11198, Middle Banks, Queensland, 27°14'S 153°20'E, sand/mud, 21m, S. Cook, September 1972, QUBS stations 28, 29 and 35. PARATYPES: 4 specimens, QM W6348, 3 specimens, QM W6349, 8 specimens, NMV J2173, 5 specimens, AM P34168, 2 specimens, QM W6351, type-locality.

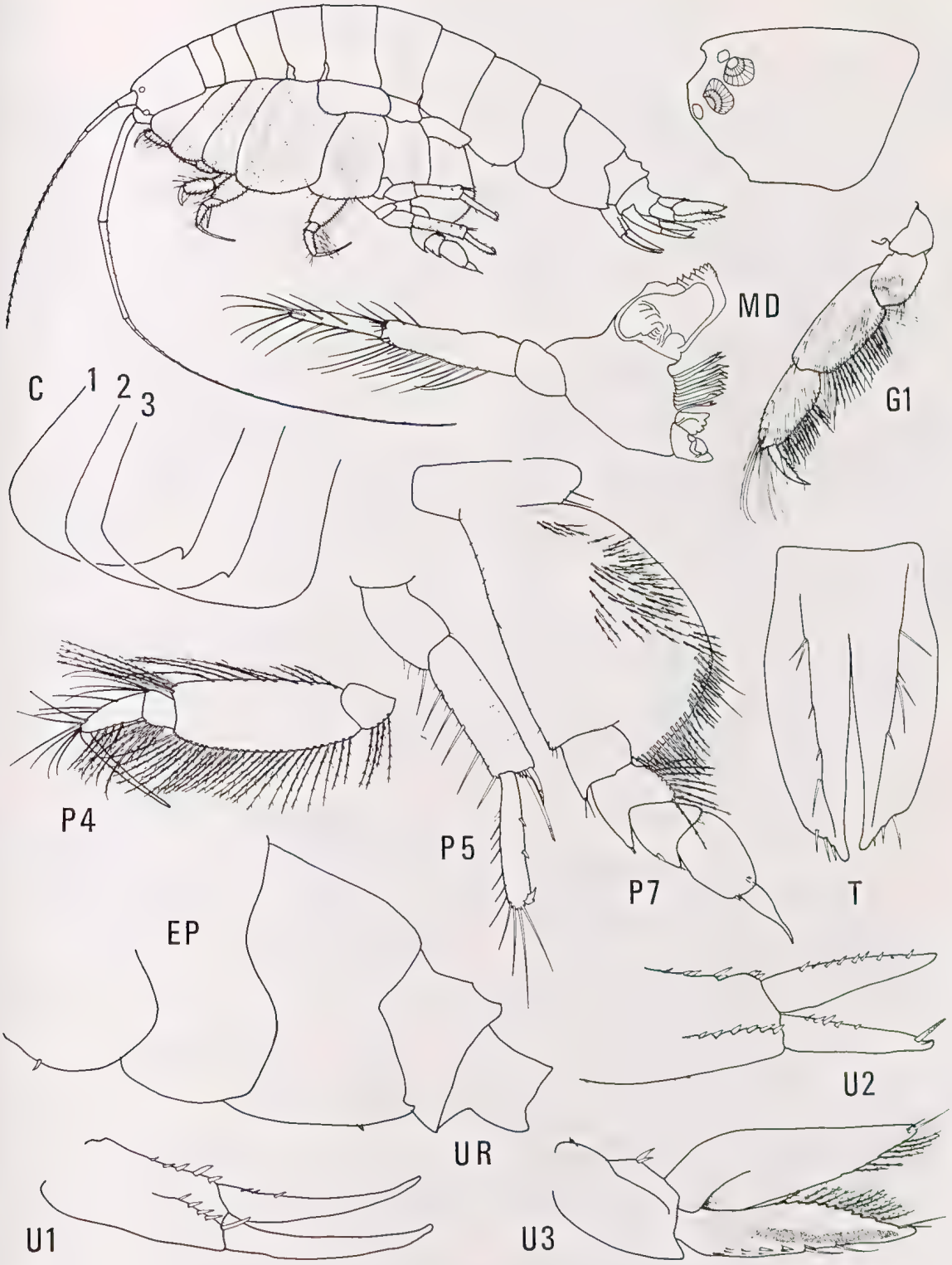

Fig. 20. *Ampelisca toora* n.sp., holotype, ll.0 mm, Port Phillip Bay, Victoria.

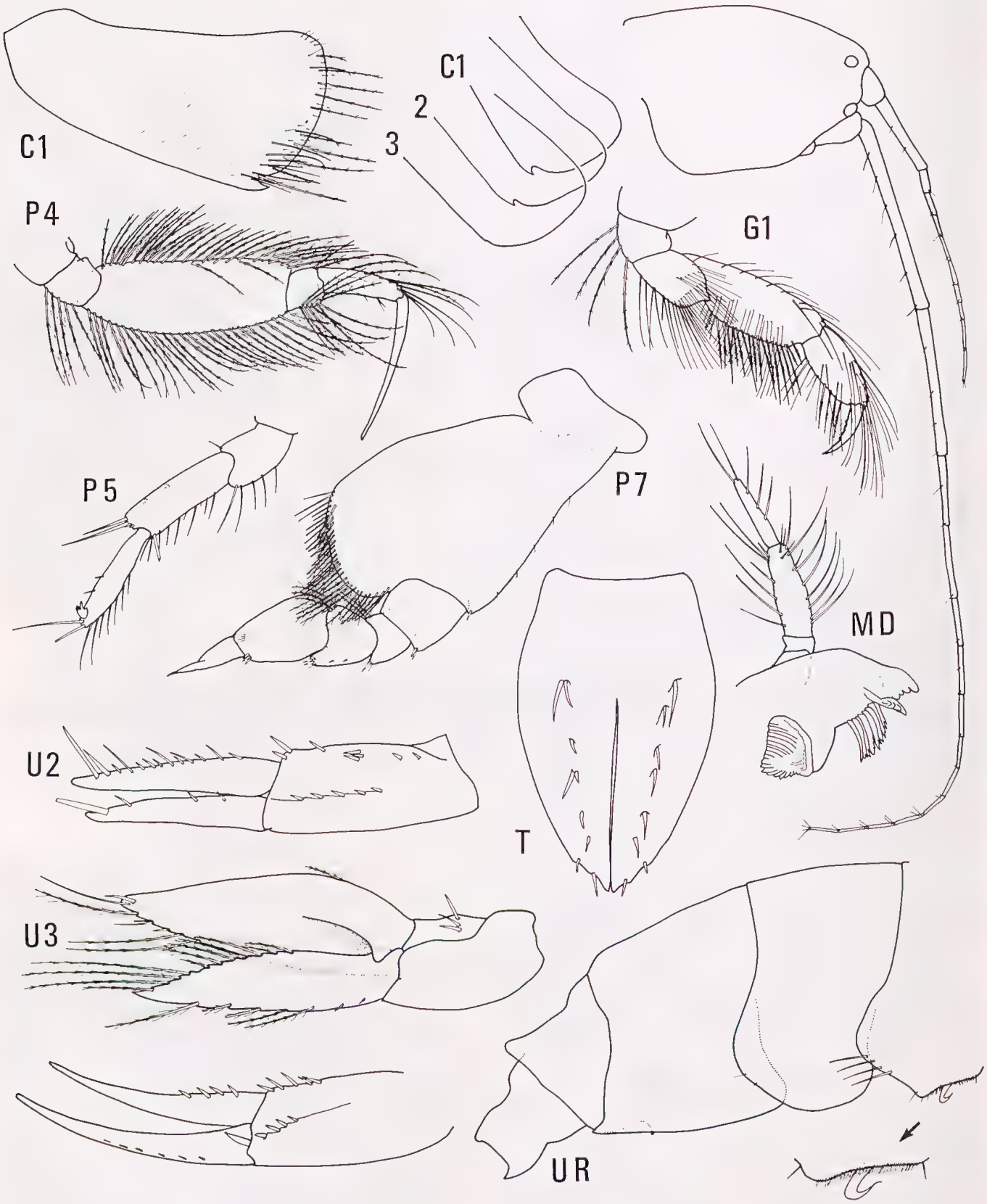

Fig. 21. *Ampelisca yuleba* n.sp., holotype, female, l0.2 mm, Middle Banks, Moreton Bay, Queensland.

Additional material. 28 specimens, QM W6352, W6353 and W11199, type-locality, 26 m, S. Cook and S. Newlands, December 1972 — June 1974.

Diagnosis. Head about 1.4 times as long as deep, without rostrum; anteroventral margin oblique; 2 pairs of eyes, each with a cuticular lens. Antenna 1 nearly as long as peduncle of antenna 2; peduncular article 2 about 2.4 times as long as article 1. Antenna 2 about half as long as body. Coxae 1 and 2 with posteroventral hooks; coxa 3 with slight posteroventral indentation. Peraeopod 4 with article 4 about 2.6 times as long as wide. Peraeopod 7, posterior margin of article 2 oblique, posteroventral corner sharply rounded, ventral margin convex, just reaching distal margin of article 3, with plumose setae; article 3 about twice as long as article 4; articles 4 and 5 with anterior lobes; article 6 inflated, about 1.5 times as long as broad, 1.2 times as long as articles 4 and 5 combined. Epimeron 1 with 4 setae along posteroventral margin and a rounded posteroventral corner; epimeron 2 with broadly rounded posteroventral corner; epimeron 3 with posteroventral corner produced into an acute tooth. Urosomite 1 with a dorsal keel becoming elevated distally; coalesced urosomites 2 and 3 with shallow dorsal saddle. Uropod 2, inner ramus with dorsal spine row of which the last subterminal spine is longer, outer ramus with 3 dorsal spines and a strong subterminal spine. Uropod 3, rami subequal, lanceolate; inner ramus with plumose setae along outer distal margin; outer ramus with plumose setae along outer and inner margins. Telson about 1.5 times as long as wide, with a row of short setae and 2 subapical setae on each lobe.

Remarks. *Ampelisca yuleba* is most closely related to *A. tilpa* as discussed under that species. *Ampelisca yuleba* is currently known only from southern Queensland. It was referred to as Amphipod 28 by Stephenson *et al.* (1978). The ventral hook on pleonite 1, seen in some species of *Ampelisca*, is particularly obvious in this species.

Distribution. Moreton Bay, Queensland; 21-26 m.

Byblis Boeck

Type-species. *Ampelisca gaimardii* Krøyer, 1846 (original designation).

Remarks. The genus *Byblis* is distinguished by the presence of setae all along the anterior margin of article 2 of peraeopod 7, and a spine-like dactyl on the same limb. Dickinson (1983) has given a more detailed diagnosis along with references to recent studies of the genus.

Byblis bega n.sp.

Figs 22, 23

Type-material. HOLOTYPE: 15.7 mm, AM P23168 (with 4 slides), 1 km east of Burwood Beach, New South Wales, 32°57.5'S 151°44.7'E, fine sand, 26 m, Shipek grab, 20 March 1975, HDWBS transect 01. PARATYPE: 1 specimen, AM P23169, type-locality, 28 m, 20 May 1975; 1 specimen, AM P22671, east of Malabar, New South Wales, 33°57'S 151°19'E, medium to fine sand, 45 m, Shipek grab, 15 May 1972, AMSBS station 2A.

Additional material. 4 specimens, AM P34158, east of Long Reef, New South Wales, dredged, 176 m, 5 December 1977, *Kapala* station K77-23-01.

Diagnosis. Head about 1.4 times as long as deep; 2 pairs of eyes, each with a cuticular lens. Antenna 1 reaching just beyond end of article 4 of peduncle of antenna 2; flagellum shorter than peduncle. Antenna 2 about one-third length of body. Gnathopod 1 simple. Peraeopod 4, article 5 two-thirds as wide as long. Peraeopod 7, article 2 strongly setose posteroventrally, obliquely lobed and narrowly rounded distally; article 5 about 1.4 times as long as articles 3 and 4 combined. Uropod 3, rami broadly lanceolate, with serrate overlapping margins. Telson as long as basal width, distally rounded, cleft 0.6 times length, each lobe bearing 2 pairs of small dorsal setae.

Remarks. *Byblis bega*, like *B. mildura*, lacks apical telsonic spines and thereby differs from most non-Australian species (see Dickinson, 1983). The species is most easily recognised by its very short antenna 1, oblique and elongate lobe on article 2 of peraeopod 7 and rounded telson.

Distribution. New South Wales shelf; 26–176 m.

Byblis gerara n.sp.

Figs 24, 25

Type-material. HOLOTYPE: female, 14.0 mm, AM P34144 (with 3 slides), east of Broken Bay, New South Wales, 33°31-33'S 152°08-01'E, dredged, 910 m, R. Springthorpe, 10 December 1980, *Kapala* station K80-20-08. PARATYPES: 3 specimens, AM P34145, and 3 specimens, NMV J2174, type-locality; 4 specimens, AM P34146, east of Broken Bay, New South Wales, 33°37-39'S 152°04-02'E, dredged, 910-892 m, R. Springthorpe, 10 December 1980, *Kapala* station K80-20-09; 1 specimen, AM P34147, east of Broken Bay, New South Wales, 33°35-37'S 152°05'E, dredged, 118 m, R. Springthorpe, 1 December 180, *Kapala* station K80-20-1.

Diagnosis. Head about 16 times as long as deep; without eyes. Antenna 1 reaching half way along article 5 of peduncle of antenna 2; flagellum longer than peduncle. Antenna 2 slightly longer than body. Gnathopod 1 subchelate, palm slightly oblique, serrate with strong spines. Peraeopod 4, article 5 as long as wide. Peraeopod 7, article 2 posterodistally lobed, posterior margin convex, distal margin broadly rounded and setose; article 4, 3 times as long as article 3, article 5 half as long as article 4. Uropod 3, rami narrowly lanceolate, with simple and plumose setae but without serrate inner margins. Telson 1.2 times as long as basal width, strongly tapering, cleft 0.7 times length, each lobe with a pair of proximal setae, 2 mid-dorsal spines and an apical spine and seta.

Remarks. *Byblis gerara* is immediately distinguished from other Australian species by the absence of eyes, the strongly subchelate gnathopod 1 with slightly

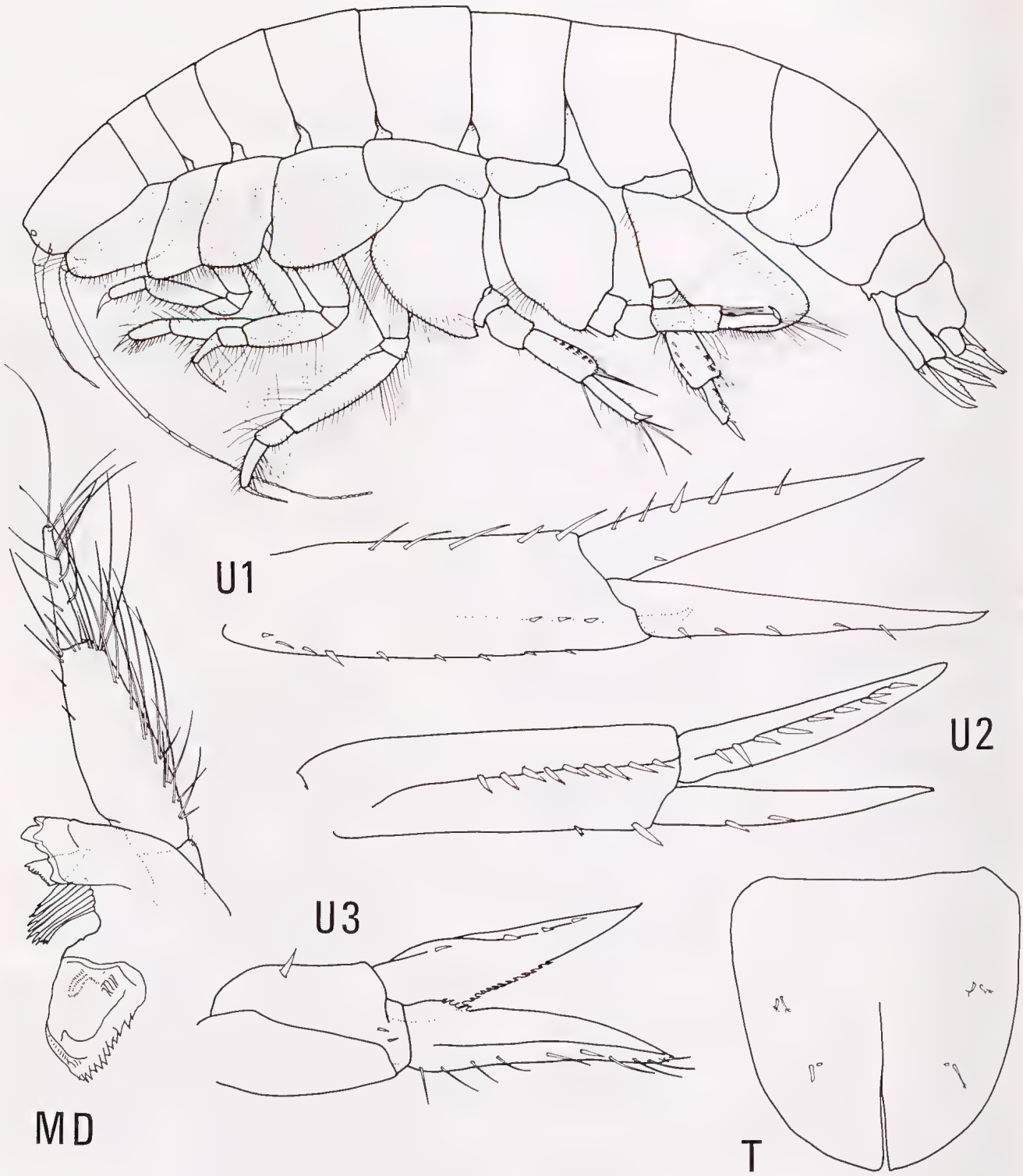

Fig. 22. *Byblis bega* n.sp., holotype, 15.7 mm, east of Burwood Beach, New South Wales.

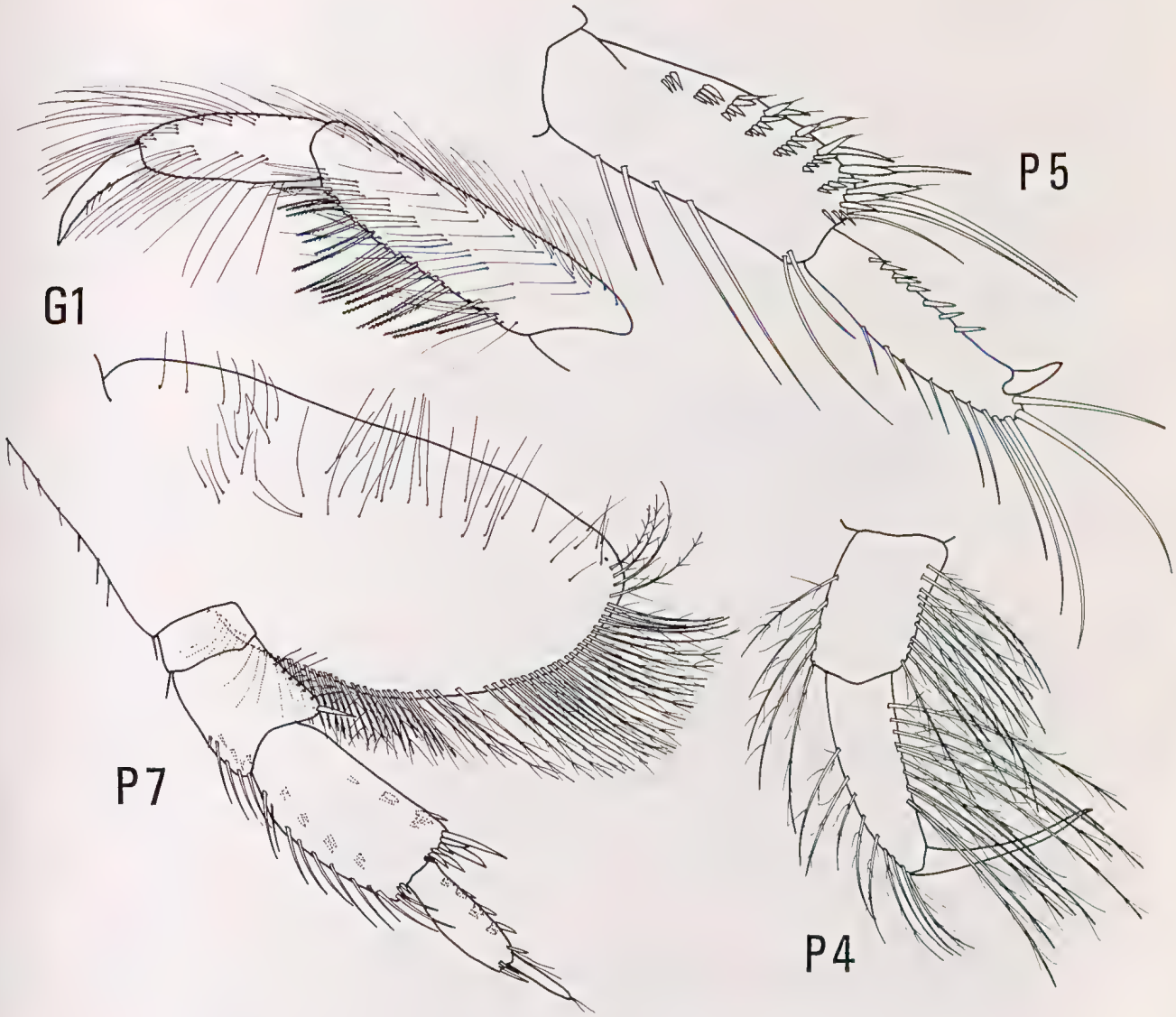

Fig. 23. *Byblis bega* n.sp., holotype, 15.7 mm, east of Burwood Beach, New South Wales.

oblique palm, and the presence of apical telsonic spines. Blind species of *Byblis* are not uncommon in deeper water (Margulis, 1967; Mills, 1971) but none possesses a first gnathopod of the form described here.

Distribution. New South Wales; slope, 892–1138 m.

Byblis mildura n.sp.

Figs 26, 27

Byblis sp. 1. — Poore *et al.*, 1975: 33, 65; Poore & Kudenov, 1978: 148, 150; Poore & Rainer, 1979: 485–490.

Type-material. HOLOTYPE: 12.2 mm, NMV J2175 (with 4 slides), Port Phillip Bay, Victoria, 38°18.7'S 144°53.3'E, sand, 18 m, 22 September 1970, PPBES station 982. PARATYPES: 9 specimens, NMV J2176, type-locality; 42 specimens, NMV J2177, Port Phillip Bay, Victoria, 38°18.7'S 144°56.7'E, sand, 19 m, 11 October 1971, PPBES station 983; 36 specimens, AM P34354, Port Phillip Bay, Victoria, 38°16.3'S 144°51.5'E, sand, silt, clay, 24 m, 8 December 1971, PPBES station 976.

Additional material. 12 specimens, QM W6354 to W6356, Middle Banks, Moreton Bay, Queensland, sand/mud, 21–23 m, S. Cook, September 1972, QUBS stations 28, 29, 34; 85 specimens, QM W6358, W6359, Middle Banks, Moreton Bay, Queensland; 4 specimens, QM W6360, Bramble Bay, Moreton Bay, Queensland; 5 specimens, QM W3718, Peel Island, Moreton Bay, Queensland; 5 specimens, AM P34148, east of Bondi, New South Wales, dredged, 80 m, R. Springthorpe, 11 December 1980, *Kapala* station K80-20-11; 6000+ specimens, AM P3419 and NMV J2178 to J2229, J5690 to J5700, Port Phillip Bay, Victoria, PPBES stations, and Crib Point, Western Port, Victoria, CPBS stations; 2 specimens, NMV J7742, central Bass Strait, 82 m, shell, bryozoans and mud, 13 November 1981, BSS station 158.

Diagnosis. Head 1.6 times as long as deep; 2 pairs of eyes, each with a cuticular lens. Antenna 1 reaching two-thirds way along article 5 of peduncle of antenna 2; flagellum longer than peduncle. Antenna 2 slightly less than half length of body. Gnathopod 1 subchelate, palm extremely oblique. Peraeopod 4, article 5 half as

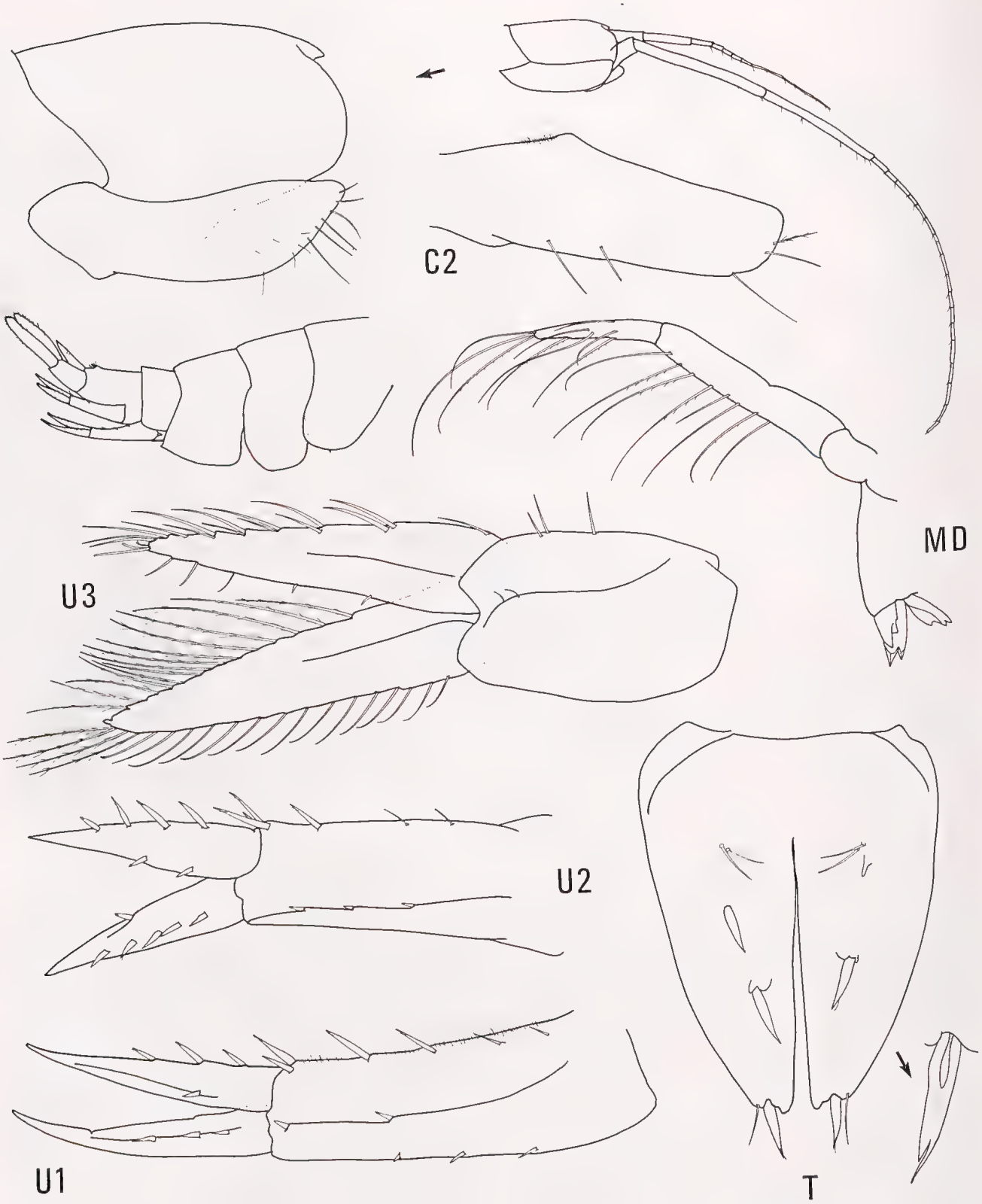

Fig. 24. *Byblis gerara* n.sp., holotype, female, 14.0 mm, east of Broken Bay, New South Wales.

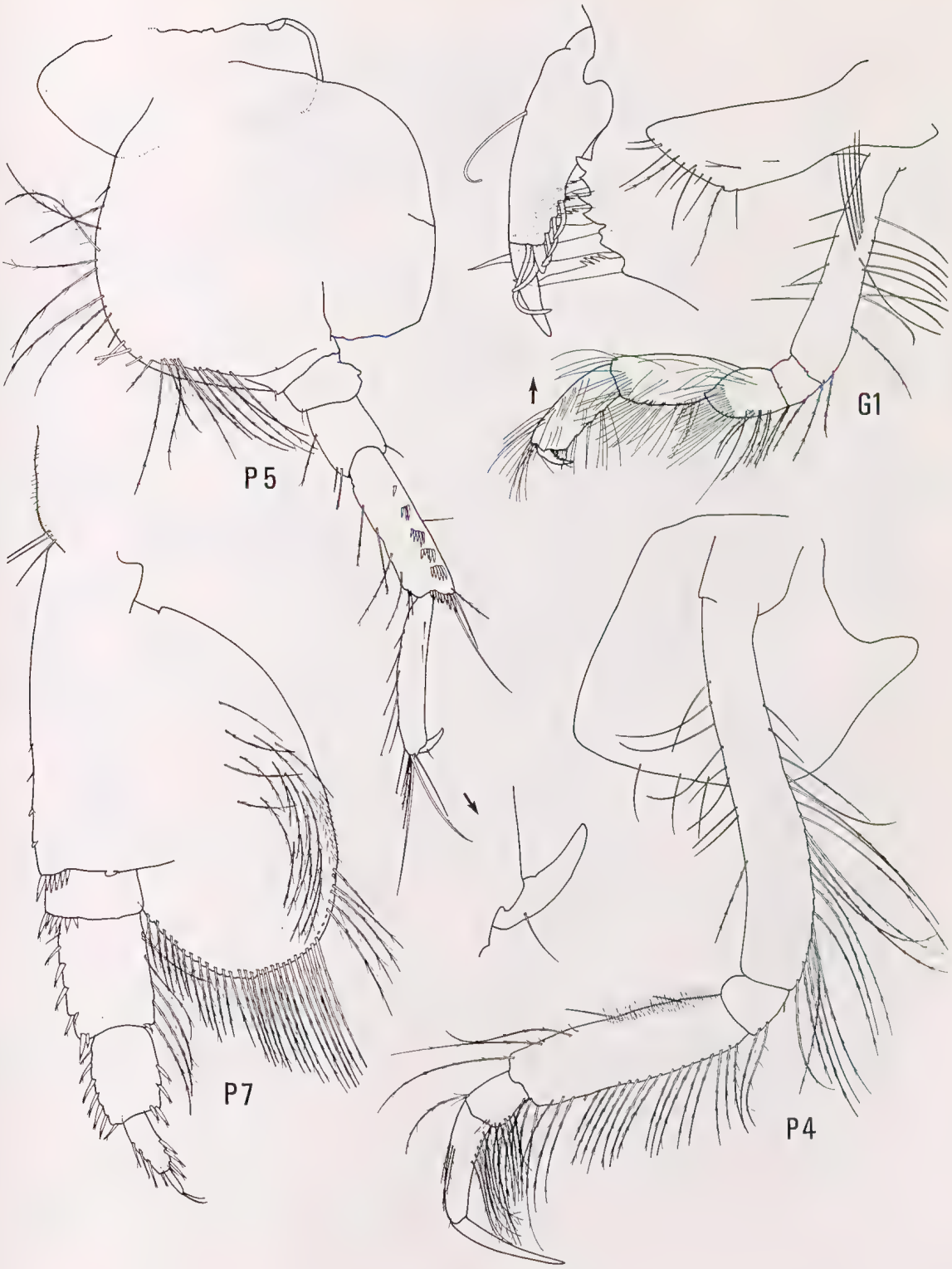

Fig. 25. *Byblis gerara* n.sp., holotype, female, l4.0 mm, east of Broken Bay, New South Wales.

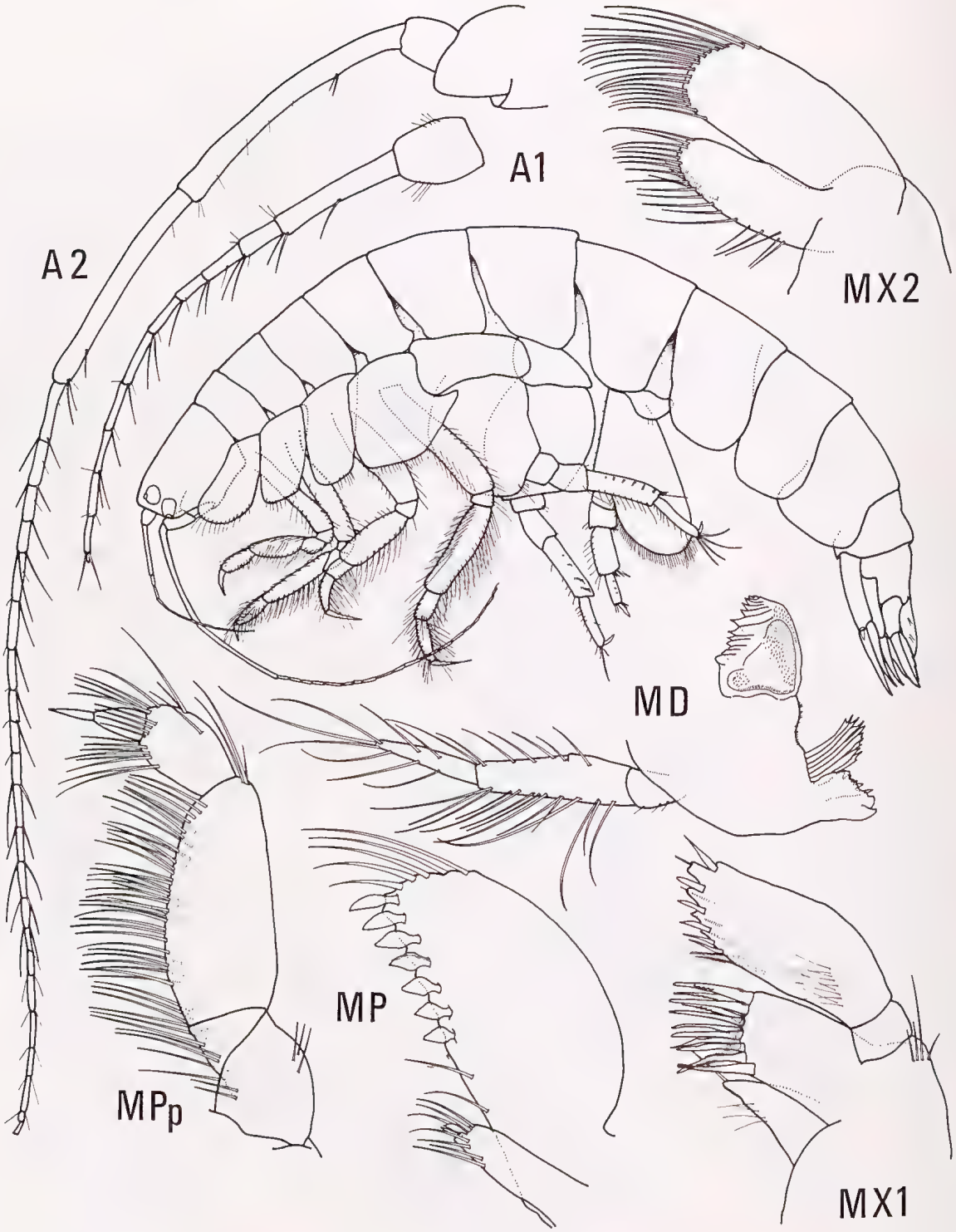

Fig. 26. *Byblis mildura* n.sp., holotype, l2.2 mm, Port Phillip Bay, Victoria.

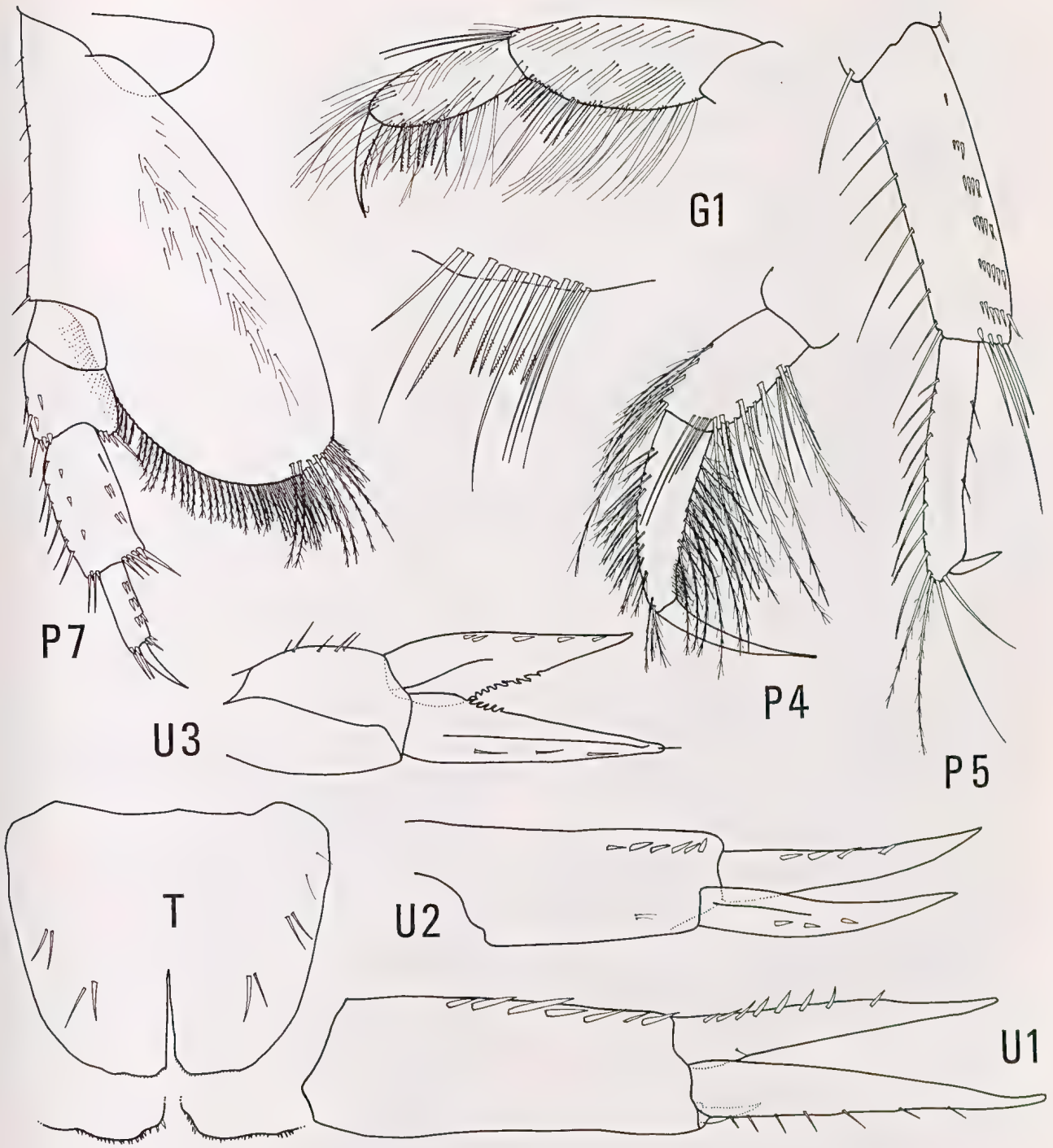

Fig. 27. *Byblis mildura* n.sp., holotype, 12.2 mm, Port Phillip Bay, Victoria.

wide as long. Peraeopod 7, article 2 posterodistally lobed, posterior margin convex, anterodistal margin broadly rounded; article 5 as long as articles 3 and 4 combined. Uropod 3, rami with serrate overlapping margins. Telson about 0.8 times as long as basal width, distally truncate with minute spinules, cleft 0.4 times length, each lobe with 2 pairs of dorsal setae.

Remarks. *Byblis mildura* is a common species most easily recognised by its persistent brown colour. Antenna 1 is almost as long as the peduncle of antenna 2, and the distal lobe of article 2 on peraeopod 7 is produced more vertically than in *B. bega*. The relationship of this species to non-Australian species is not clear. It seems that no other described species possesses the truncate telson with minute spinules of *B. mildura*.

Quantitative studies in Port Phillip Bay have shown *B. mildura* to be the most abundant ampeliscid on

muddy sediments, with a mean density from many samples in this environment of about 35/m^2 (Poore *et al.*, 1975). Long-term monitoring of population density has shown it to vary substantially from year to year, up to a maximum of 1200/m^2 (Poore & Rainer, 1979). This species was referred to as Amphipod 8 by Stephenson *et al.* (1978).

Distribution. Queensland, New South Wales, Victoria; bays and shelf, 10–82 m.

Byblis tinamba n.sp.

Fig. 28

Type-material. HOLOTYPE: 7.4 mm, NMV J7752 (with 3 slides), south of Lakes Entrance, Bass Strait, 38°18'S 147°15'E, muddy fine shell, 55 m, 31 July 1983, epibenthic sled, BSS station 209. PARATYPES: 5 specimens, NMV J7753, type-locality; 18 specimens, AM P34703, eastern Bass Strait, 38°52.6'S 148°25.2'E, sand, 140 m, BSS station 170; 3 specimens, NMV J7754, east of Wilsons Promontory, Bass Strait, 39°03.2'S 146°39.5'E, muddy sand, 55 m, BSS station 179; 4 specimens, NMV J7755, south of Wilsons Promontory, Bass Strait, 39°12.9'S 146°27.3'E, muddy sand, 65 m, BSS station 180; 4 specimens, AM P34704, south-east of Lakes Entrance, Bass Strait, 37°59'S 148°27'E, muddy sand and shell, 51 m, BSS station 207.

Additional material. 9 specimens, NMV J7756 to J7760, western Bass Strait, 52–207 m, BSS stations 65, 68, 84, 130 and 187.

Diagnosis. Head slightly longer than deep; 2 pairs of eyes, each with a cuticular lens. Antennae 1 and 2 of similar length, about half as long as body; antenna 1, flagellum twice as long as peduncle. Gnathopod 1 subchelate, palm extremely oblique. Peraeopod 4, article 5 about as wide as long. Peraeopod 5, dactyl with a small anterior accessory tooth. Peraeopod 7, article 2 posterodistally lobed, posterior margin slightly convex, posterodistal corner sharply rounded; article 4 with long posterior setae; article 5 as long as article 4. Uropod 3, inner ramus with inner margin serrate. Telson 0.6 times as long as basal width, broadly rounded, cleft half length, each lobe with 3 lateral setae proximally, a pair at about the mid-point and a seta and a spine on the distal half.

Remarks. *Byblis tinamba* is distinguished from other Australian species by its subequal antennae and the shape of article 2 on peraeopod 7.

Distribution. Bass Strait; 51-207 m.

Haploops Liljeborg

Type-species. *Haploops tubicola* Liljeborg, 1852 (original designation).

Remarks. Species of the genus *Haploops* are easily distinguished by the more or less rectangular, rather than triangular, second article of peraeopod 7. Most known species are from the deep-sea, as is the case of the only known Australian species.

Haploops oonah n.sp.

Figs 29, 30

Type-material. HOLOTYPE: 7.9 mm, AM P34150 (with 4 slides), east of Port Kembla, New South Wales, 34°27-26'S 151°27'E, dredged, *Globigerina* ooze, 1200 m, J.K. Lowry, 13 December 1976, *Kapala* station K76-23-02. PARATYPES: 15 specimens, AM P25473, 4 specimens, NMV J2230, type-locality.

Additional material. One specimen, NMV J7741, eastern Bass Strait, sandy mud, 1120 m, pipe-dredge, BSS station Q631.

Diagnosis. Head about 1.2 times as long as deep, without a rostrum, anterior margin more or less vertical; one pair of eyes with cuticular lens. Antenna 1 longer than peduncle of antenna 2, about 0.8 times length of antenna 2; peduncular article 2 slightly longer than article 1. Antenna 2 as long as body. Peraeopod 7, article 2 broadest proximally, posterior margin concave and setose, posterodistal lobe obliquely angled and reaching beyond distal margin of article 3; article 3 rectangular, shorter than broad, with a distal spine row; article 4 almost 3 times as long as article 3, broader distally and with posterior and distal spine rows; article 6 as long as article 5, anterior and posterior margins convex; article 7 short, cylindrical with a distinct unguis. Epimera 2 and 3 with square posteroventral corners. Urosomite 1 with a rounded, triangular dorsal crest. Urosomites 2–3 with a pair of small dorsolateral bosses near anterior margin. Uropod 1, rami unarmed. Uropod 2, rami each with a single dorsal spine row. Uropod 3, rami tapering distally, truncate; outer ramus with 2 spines and distal setae; inner ramus with distal setae on both margins. Telson slightly longer than wide, cleft 0.7 times length, lateral margins convex and tapering, each lobe distally rounded, with a subterminal spine and seta.

Remarks. *Haploops oonah* is most closely related to *H. descansa* J.L. Barnard, 1961, which is known from the eastern Tasman Sea. *Haploops oonah* is distinguished from *H. descansa* by its longer first antennae, well-developed distal spines on article 3 of peraeopod 7, less spinose article 5 on peraeopod 7 and square posteroventral corner on epimeron 3. *Haploops lodo* J.L. Barnard, 1961, is also related to this species group but is distinguished from *H. oonah* by its lack of cuticular lenses and its rounded posteroventral corner on epimeron 3.

Distribution. New South Wales, Bass Strait; slope, 1120-1200 m.

ACKNOWLEDGEMENTS. We thank the Directors of the Australian Museum and the Museum of Victoria for providing travel funds; Roger Springthorpe for composing and inking the plates; Helen Stoddart, Helen Lew Ton and Graeme Milledge for other technical assistance; and Peter Davie for lending us the ampeliscid collection of the Queensland Museum.

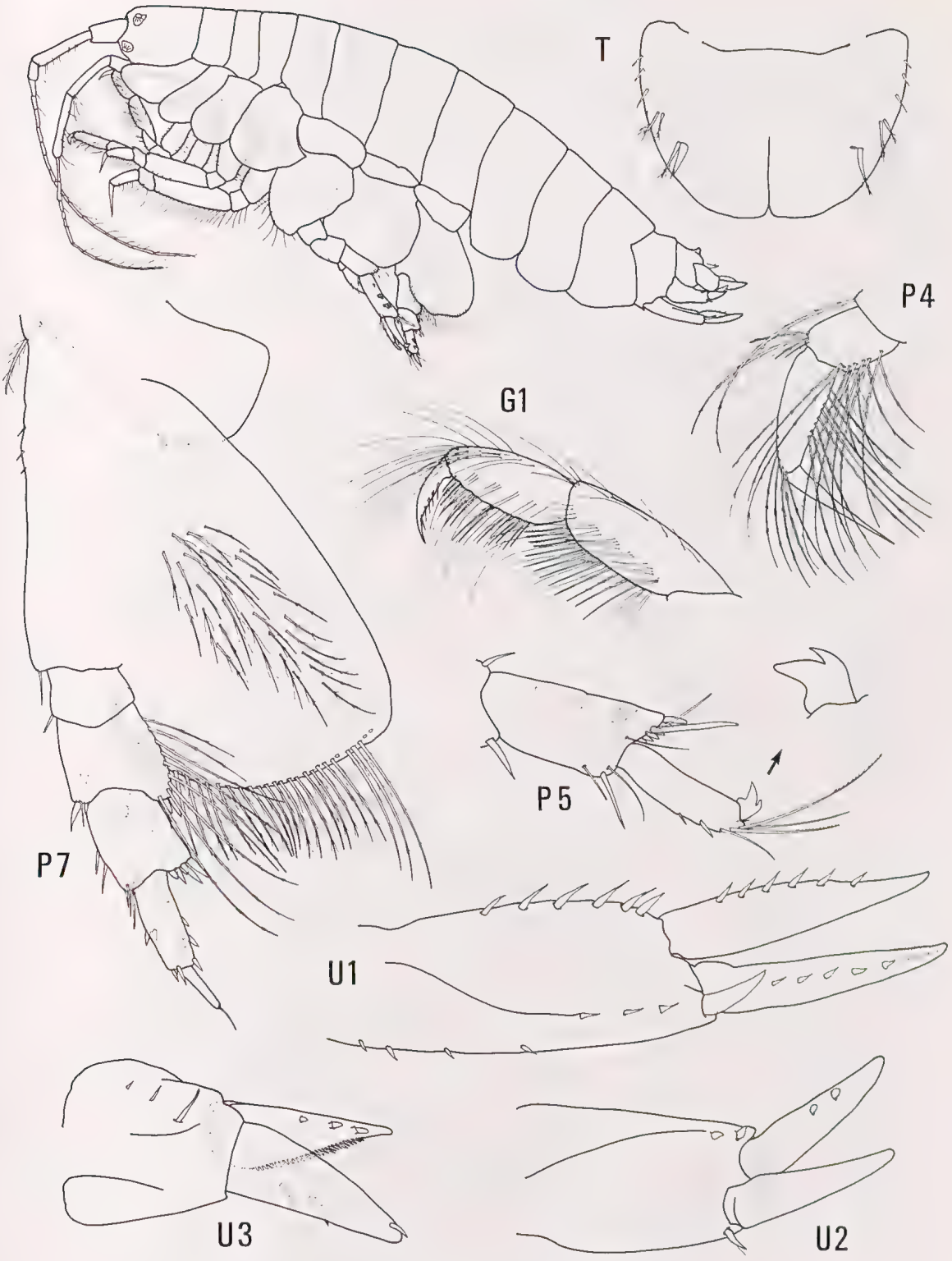

Fig. 28. *Byblis tinamba* n.sp., holotype, 7.4 mm, Bass Strait.

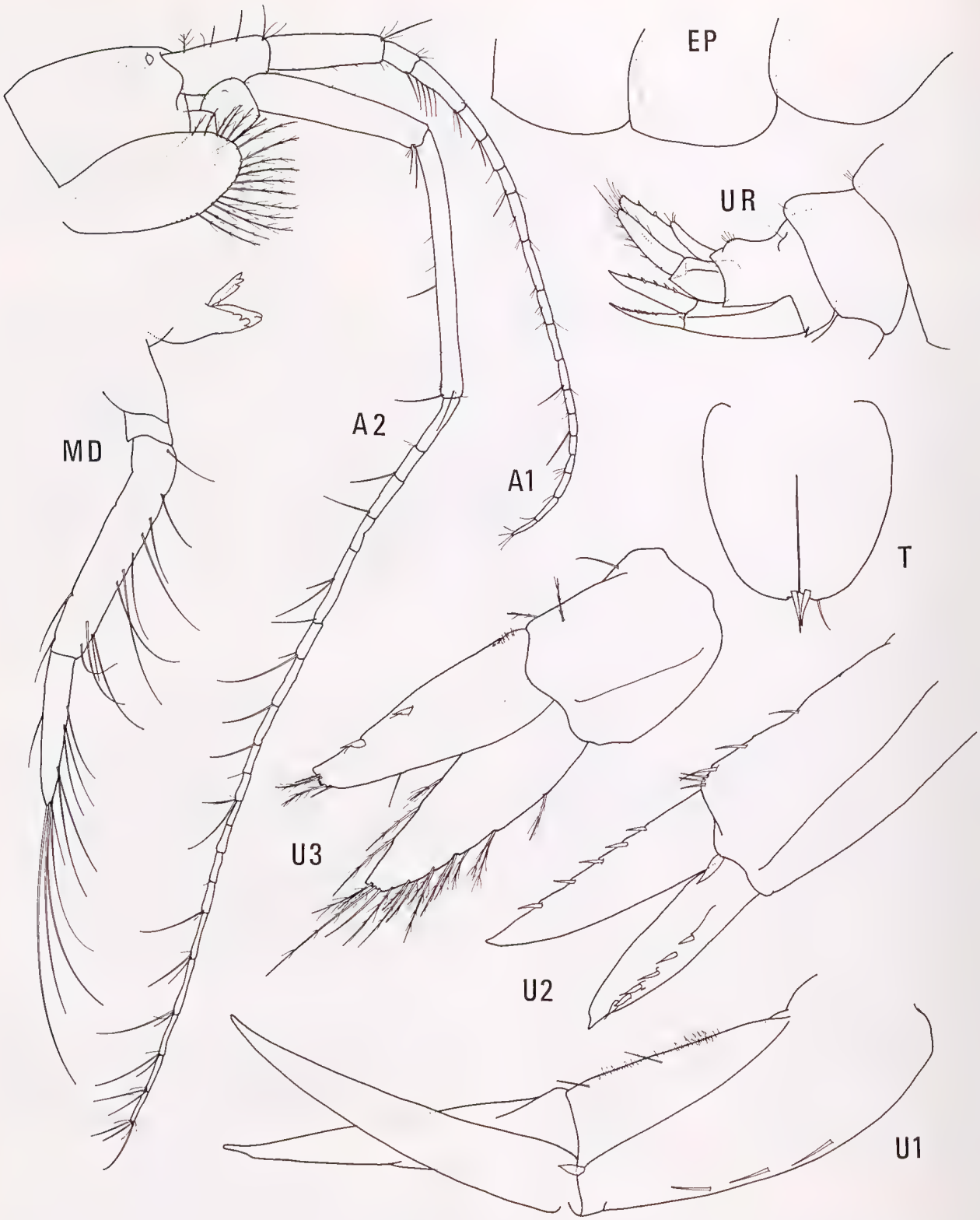

Fig. 29. *Haploops oonah* n.sp., holotype, 7.9 mm, east of Port Kembla, New South Wales.

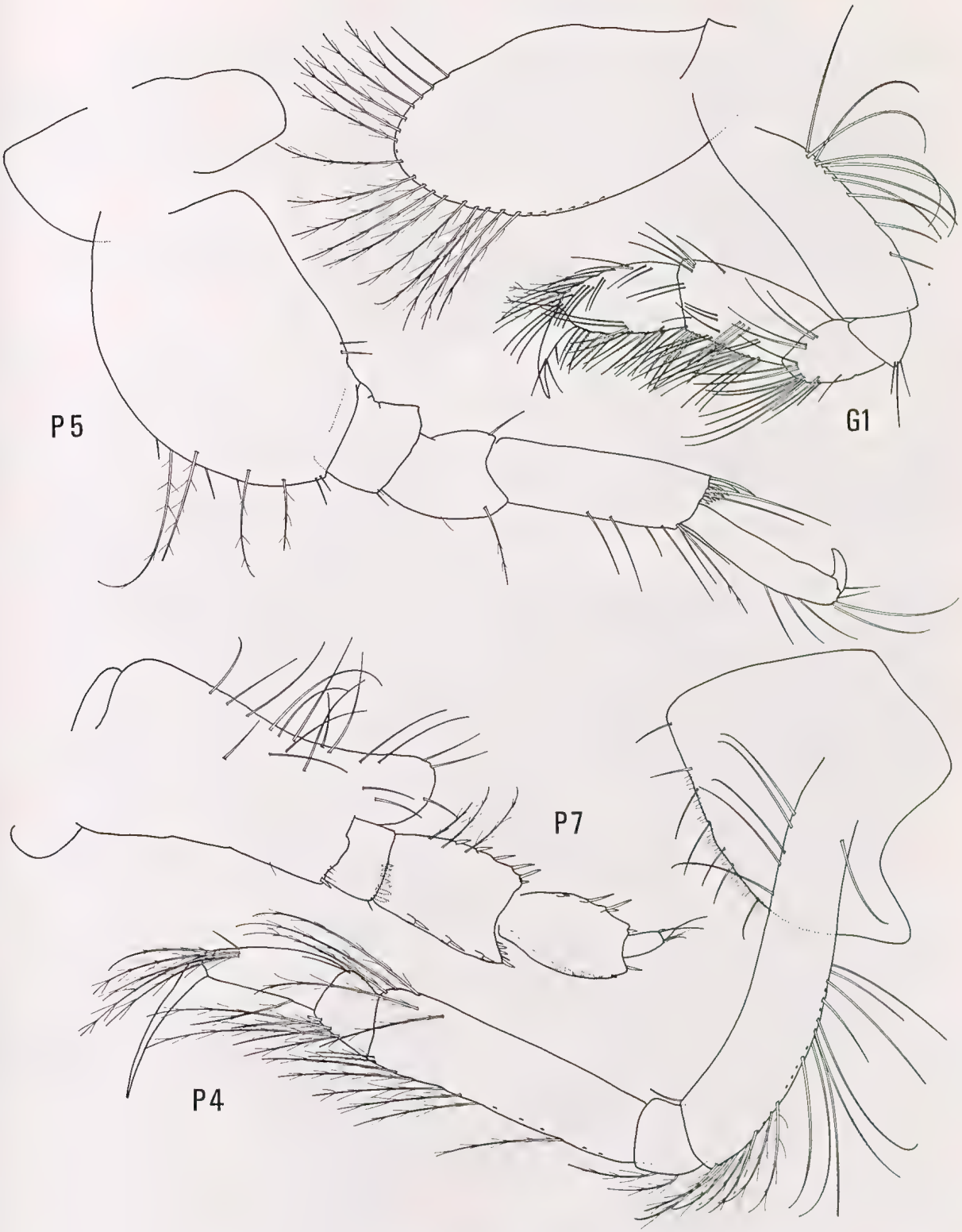

Fig. 30. *Haploops oonah* n.sp., holotype, 7.9 mm, east of Port Kembla, New South Wales.

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Occurrences and Origins of Gem Zircons in Eastern Australia

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Abstract. In eastern Australia, zircons are common in alluvial deposits derived from Tertiary volcanic rocks. They are typically accompanied by corundum, pleonaste spinel and ilmenite ('the zircospilic association'). Although most occur in or near granite areas, fieldwork and dating confirm alkali basalts and some trachytes as their hosts; some even being found *in situ*. Most crystals show corrosion effects from their transporting magmas.

A wide range of zircon crystal habits suggests diverse but, as yet, unknown sources. Possibilities include: (a) accidental sources from syenitic intrusives, plutonic cumulates and pegmatites, and (b) cognate origins in fractionated basaltic magmas, particularly their felsic end members. Dry, peraluminous alkaline magmas may be responsible for most of the large zircons. Eight groups are described on their physical characteristics. Most are (101)-pyramid dominant forms with short prisms. Variations in the incidence of crystal types show trends that may record changes in magma composition as well as temperature profiles.

Felsic intrusions associated with Mesozoic and Cainozoic 'hot spot' trails form potential reservoirs to provide zircon xenocrysts in later basalts. The relative contribution of these to older Palaeozoic granitoid zircon sources is uncertain, pending detailed isotopic work.

Hollis, J.D. & F.L. Sutherland, 1985. Occurrences and origins of gem zircons in eastern Australia. Records of the Australian Museum 36(6): 299-311.

Keywords: zircons, alluvial gems, eastern Australia, crystal forms, basaltic sources, alkaline origins, fission-track dates.

Alkali basalts containing megacrysts of zircon are reported from a few localities in eastern Australia (eg. Binns, 1969; Stephenson, 1976) and we report several new occurrences. They may be accompanied by corundum, pleonaste and ilmenite, comprising the 'zircospilic association' of Hollis (1984). Similar occurrences are known from the Eifel, West Germany (Dana, 1898) and Irving & Frey (1984) list other records from France, Scotland, Algeria, Madagascar, Nigeria and South-East Asia. A further record comes from Thailand (Vichit *et.al.*, 1978). Derived alluvial occurrences are widespread in eastern Australia (Fig.1) and some yield gem zircons. These can exceed fist size in the Anakie Gemfield, Queensland. Large zircons (over 2 mm) also occur in trachytes and trachytic pyroclastics at Blue Mountain, Victoria, and Elsmore Hill, New South Wales (Lishmund & Oakes, 1983). Although small zircons are often abundant in alkali granitic rocks, large zircons are very poorly represented by an unconfirmed pegmatite source near Rubyvale, Qld, and a syenite at Jingera, N.S.W.

Zircons derived from alkali volcanics generally show rounding and sometimes fine surface corrosion textures, clearly distinct from abrasion produced by subsequent alluvial transport. A few crystals are completely sharp and uncorroded. A range of origins is suggested, from cognate and in equilibrium with their host magmas to accidental, disequilibrium xenocrysts. Fission-track dating of alluvial zircons gives results consistent with local volcanic sources (Gleadow, *et.al.*, 1976; Yim, *et.al.*, 1984.)

Interest in sapphires has generally overshadowed the zircons, about which only passing references are made. This study outlines important occurrences of large

('gem') zircons and their physical groupings, especially crystallography. Some implications regarding their origins, based on crystal morphologic studies, are examined with reference to the work of Pupin (1980), Caruba (1978) and Kostov (1973).

Uranium contents of a number of the zircons described here, from the Australian Museum collections, have been reported by Mumme (1967) and are greater than those typical of kimberlitic occurrences (Davis, 1976). Further U values are given in Table 2.

Physical Characterisation of Zircons

Morphologic classification of zircon crystals has been extensively studied by Pupin (1980) who adopted a logical crystallographic scheme based on experimental temperature and alkalinity relationships with melts. These relationships have been questioned by Caruba (1978) and it appears that other factors such as melt compositions, water content and cooling rates play important roles in determining crystal types (Kostov, 1973). Pupin delineated fields of crystal types characterising different igneous rocks, including a trend for gem zircons from alkali basalts. The gem zircon field was based on limited material and different trends have emerged from the present work. Pupin's chart proved too complex for objective crystal classification of the gem zircons, as many show differing form developments on the one crystal. The scheme adopted (Fig.2) proved ideal for trend delineation from crystal counts.

Kostov (1973) showed that melts low in U, Th, alkalis and water produced (100)-dominant crystals. Pupin & Turco (1973) regarded these forms as typifying high-temperature, peraluminous magmas. (110)-dominant crystals were conversely rich in U, Th, alkalis and water and developed at lower temperatures. Prismatic crystals result from rapid growth, whereas bipyramidal forms indicate slow development (Kostov, 1973).

Zoning is widespread in large zircons, sometimes producing colour banding parallel to the pyramid faces (Rubyvale brown crystals) and darker colouration along interfacial edges (Bullenmerri). Density of fission tracks also shows strong zoning, occasioned by differing U, Th contents.

Colour is an important distinguishing feature for some zircon assemblages. The crystal counts for the four Horse Gully groups (Fig.3) show distinct results for each colour group. Gem zircons broadly define scarlet, brown (colourless to deep brown) and mauve-orange colour groups. The latter often show irregular patchy colouration. Pale green to deep blue-green varieties are rare but occur in most of the groups noted. One Elsmore Hill crystal showed sharp zoning from deep blue-green to scarlet. Pale green zircons are fairly common at Bullenmerri.

Colour centering in natural zircons, including New England examples, was investigated by Fielding (1970) who showed a link between U and certain trace elements, notably praesodymium and erbium. Blue-green and scarlet zircons from Blue Mountain, Victoria,

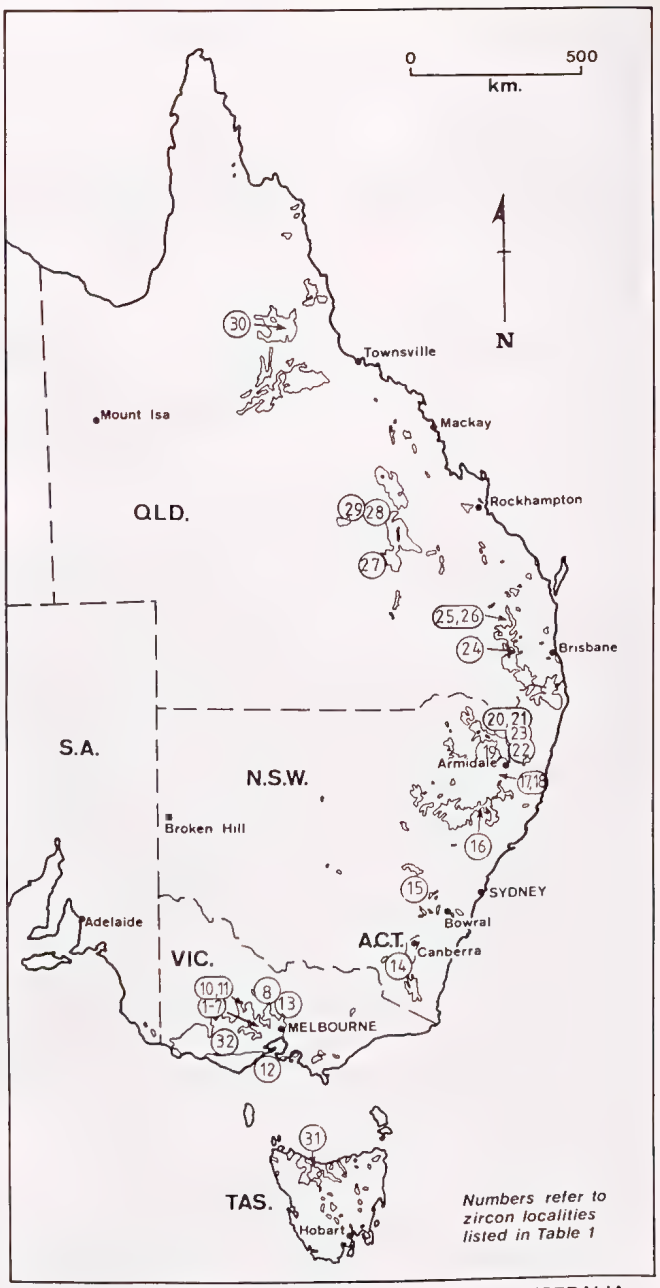
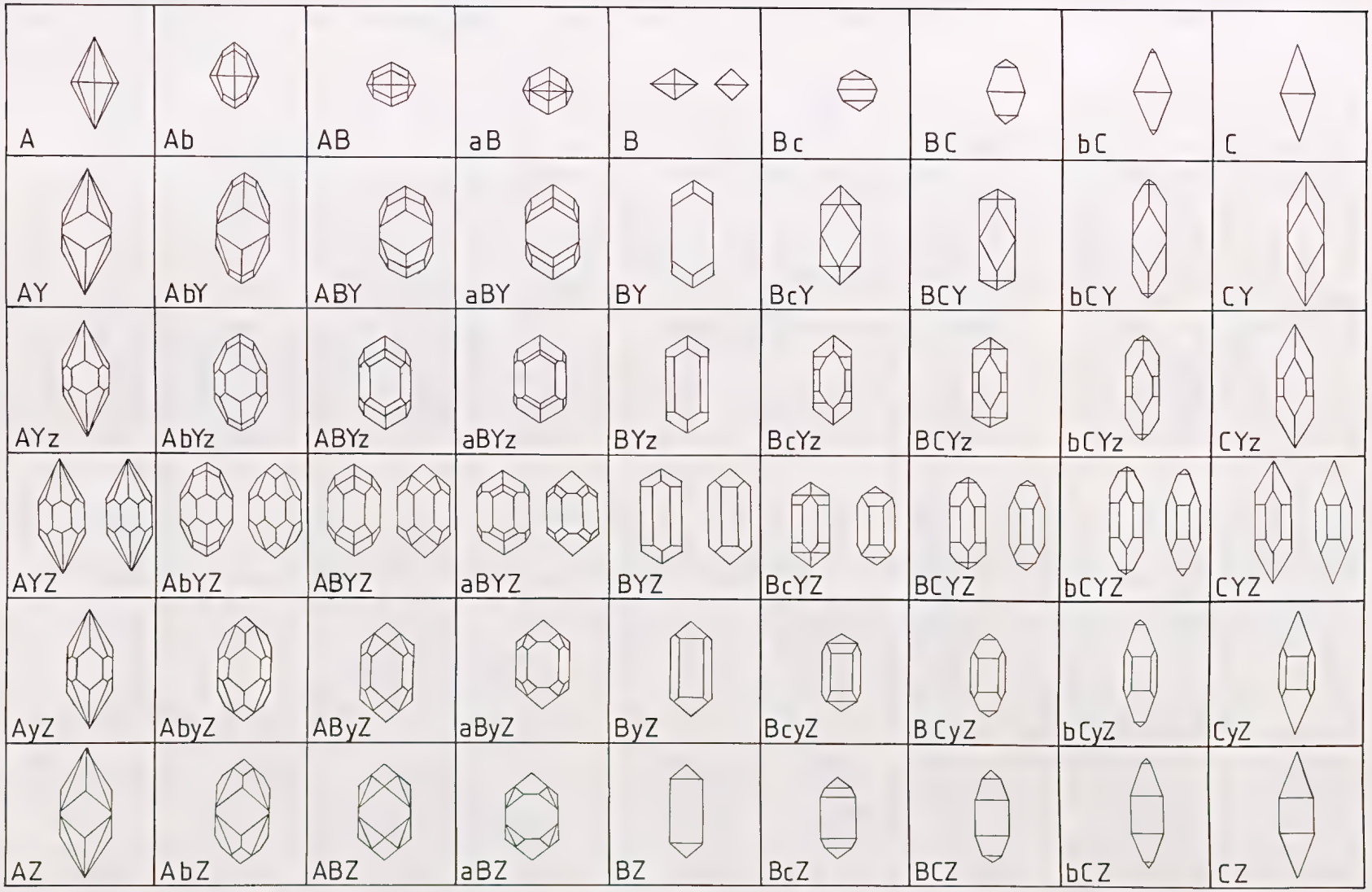


FIG. 1 DISTRIBUTION OF BASALTS, EASTERN AUSTRALIA

showed similar fission-track densities, indicating that lattice damage does not necessarily determine colour (A.Gleadow, pers.comm.).

Randomly orientated rutile needles are widespread in the scarlet crystals. Other phases include ilmenite crystals and rods of apatite. Bullenmerri zircons show higher levels of radioactivity which cannot be accounted for by microprobe analyses of U and Th. Small opaque inclusions, yet to be identified, may include allanite and other radioactive phases.

Surfaces usually show etching features, largely produced by magmatic or gaseous corrosion. These range from glossy, rounded surfaces to finely peaked



PYRAMIDS:
A = 211
B = 101
C = 301
D = 201
E = 321

PRISMS:
Y = 110
Z = 100

PINACOID:
P = 001

Lower case indicates minority form, eg. bCyZ = 301 ≫ 101, 100 ≫ 110.

Fig. 2 Crystal characterisation chart for common zircon forms. Systematic arrangement reflects an upward progression from (100) to (110) prisms, and a sequence, from left to right, from (211) through (101) to (301) pyramids. The general scheme is a simplified adaption of Pupin's scheme (1980). No rigid relationship between crystals, temperatures and alkalinity is implied, however the progression upwards may reflect decreasing temperatures and alkalinity of magams.

a) Zircon crystal census:
(%) Red Group from HORSE GULLY

			1	3				
		*	2	2	X			
		1	2	1	X	X	X	
	X	*	4	3		*	X	
	*	3	9	27	3	1	1	

Other Combinations: 3%
aBcY X
ABCZ X
abCyZ X
abCYz X
aBcyZ X
aBcYZ X

Total Crystals Counted: 204
Unidentifiable distortions: 25% (51)
X = <1% * = <1·5%

b) Zircon crystal census:
(%) Honey Group from HORSE GULLY

			2	1				
	X	1	3	1	X			
	1	3	3	2				
	*	3	5	2				
X	3	9	17	2	*			

Other Combinations: 5%
ABpZ 2%
aBcZ X
ABcZ X
aBcYZ X
aBcyZ X
AbpyZ X
ABpYz X
ABpyZ X
BpYz X

Total Crystals Counted: 263
Unidentifiable distortions: 35% (91)
X = <0·5% * = <0·8%

c) Zircon crystal census:
(%) Brown Group from HORSE GULLY.

		2	5	6				
	*	5	18	8	*			
	*	5	4	3				
		5	5	4	2			
		X	2	4	X			

Other Combinations: 6%
aBcYz *
aBcyZ *
aBcYZ *
ABcYZ X
BypZ X
BPZ X

Total Crystals Counted: 154
Unidentifiable distortions: 11% (17)
X = <1% * = <1·5%

d) Zircon crystal census:
(%) Mauve - Orange Group from HORSE GULLY.

		*	3	7				
	4	12	35	11				
		2	3	2				
		*	3	X				
		X	*	X				

Other Combinations: 5%
aBYzp X
ByZp X
aBcYz *
ABcYz *
aBcyZ X

Total Crystals Counted: 152
Unidentifiable distortions: 10% (15)
X = <1% * = <1·5%

e) Zircon crystal census:
(%) Total from BULLENMERRI.

			X	32	14	3	*	
			*	31	8	1	*	
		X	*	2	X			
			*	*		X	X	
			*	X				
				1	X	X		

Other Combinations: * %
BcdY
ABcYz
aBcyZ
abCdyZ

Total Crystals Counted: 864
Unidentifiable distortions: 2% (19)
X = <0·4% * = <0·8%

f) Zircon crystal census:
(%) Total from BOATHARBOUR.

				*	1			
		1	3	44	11			
	X	2	2	12	8			
		X	*	4	3			

Other Combinations: 4%
ABcY X
ABcYz *
ABceYz X
aBceYz *
aBcYZ X
ABcYZ X

Total Crystals Counted: 210
Unidentifiable distortions: * % (2)
X = <0·5% * = <1%

Fig. 3. Crystal census of some large zircon groups from eastern Australia: **a.** Newbury Group, Horse Gully, east of Inverell, N.S.W. **b.** Inverell Group, Horse Gully. **c.** Nundle Group, Horse Gully. **d.** Elsemore Group, Horse Gully. **e.** Boatharbour Group, Sisters Creek, Boatharbour, Tas. **f.** Bullenmerri Group, Lake Bullenmerri, near Camperdown, Vic.

or mammillated textures similar to those seen on garnets from Ballogie, Qld (Hollis *et.al.* 1983). Deep, rounded cavities probably represent dissolved, prismatic inclusions.

Groupings based on colour and crystal types may also show distinctive size ranges and degrees of prismatic development (Table 1). The Lyonville Group excepted, gem zircons show very few crystals smaller than 1 mm. Crystals below 2 mm seldom show recognisable crystal form, due to corrosional rounding. This indicates that zircons were seldom in equilibrium with their final melt environments and small crystals were dissolved. This is in direct contrast to the small prismatic zircons of acid granites (*sensu lato*) which are mostly smaller than 0.5 mm.

Classification of Zircon Assemblages

Large alluvial zircons from eastern Australia can be divided into eight morphologic groups based on crystals, colours and sizes (Table 1). These groups are named after localities where host rocks are known, and they are listed in order of major crystal development. The Newbury and Nundle Groups are proving widespread, but three others are so far only known from single localities. Present data are insufficient to determine relationships with hosts, but sharp uncorroded euhedra of the Lyonville Group appear to be cognate to their host trachytes. Others, especially the larger sizes, may be derived from rocks that are not directly related to their hosts. Predominant crystals are listed from Fig.2 which is a modification of Pupin's scheme. Decreasing temperatures appear to favour (110) prism development, although Pupin's (1980) tight relationship between crystals and temperatures ('Indice T') is questioned (eg. Caruba, 1978). Increasing alkalinity appears to shift crystal development towards (101) and (301) pyramids (Pupin's 'Indice A').

Other groups may be delineated with further work, but assemblages examined suggest that the existing groups are well defined. Large zircon assemblages are described from key localities, typifying occurrences associated with alkali volcanics in eastern Australia. More than one zircon group may be present in assemblages, particularly in Central Victoria and in the New England and Central Queensland sapphire fields, indicating multiple origins.

1. Upper Loddon River, Lyonville, Vic. Alluvium in the Loddon River, upstream from Lyonville Springs, contains abundant zircon, ilmenite, rarer black spinel, magnetite and corundum. Most of the heavy minerals are derived from the late Tertiary trachytes at Babbingtons Hill and the Quaternary basalts of the Bullarto Plateau. There are three distinct groups of zircon:

(a) Newbury Group: these constitute the largest and most abundant zircons, ranging from 0.5 to 5 mm. Although showing little abrasion, most crystals are well rounded due to magmatic corrosion. Colours are typically scarlet to orange-red; more rarely shades of grey, brown, green and blue are found, and a few are parti-coloured green and brown. Euhedra are practically all (101) pyramids with short (100) prisms, representing forms taken by Pupin (1980) to indicate hot, dry, alkaline source magmas. Zircons of identical habit come from an olivine basalt at Newbury, south of Lyonville. A similar host rock is envisaged for the Newbury Group zircons from Lyonville Springs.

(b) Lyonville Group: distinctively sharp, uncorroded euhedra between 0.2 and 1 mm; pale orange to almost colourless. (211) faces are usually developed with the (101) + (100) forms and acicular inclusions of rutile are abundant.

(c) Colourless type: small, elongate and abraded crystals range from 0.05 to 0.3 mm. Although crystal morphologies are mostly obscure, a range of medium to highly developed prismatic forms are represented. Complex (100), (110), (101) and (211) combinations occur. These are types that typify some shallow-crustal granites. As there are no outcropping granites in the area it seems likely that these small zircons have been recycled from the local Ordovician sandstones or from former Permian tillites.

2. Blue Mountain, near Trentham, Vic. A quarry on the northeastern slopes of Blue Mountain exposes deeply weathered biotite-anorthoclase trachyte overlying related ashes and agglomerates. Both yield mainly pale orange zircon euhedra that are uncorroded and up to 2 mm. Crystal forms lie in the BZ-ABZ range (Fig.3), typifying the Lyonville Group. Zircons are probably cognate microphenocrysts and are associated with abundant magnetite crystals. Similar zircons are common in soil developed from trachyphonolite at Mt Wilson, from trachyte at Babbingtons Hill and McAlister Hill, and from soda trachyte at Camels Hump, Mt Macedon, all in the same region. These trachyte centres belong to the Woodend Group, dated at around 6 Ma (Ewart et.al., 1984).

3. Leonards Hill-Sailors Creek, near Daylesford, Vic. Red soil resting on alkali basalt on the western slopes of Leonards Hill, south of Daylesford, yields abundant prismatic mauve-orange zircons, up to 9 mm long (Daylesford Group). Many are sharp euhedra although most are corroded and they often show semi-skeletal development with tubular cavities and embayments parallel to the C axes. Crystal forms show a peak occurrence between the Newbury and Lyonville Groups, to which they are probably related. Crystals in and above the (a)ByZ range are absent. Their strongly prismatic and skeletal habits make them distinctive. They occur associated with late Tertiary alkali basalts and derived alluvials in a region some 25 km across, to the south and west of Daylesford, including Hepburns Lagoon and the Newlyn ('Bullarook') area deep leads.

Sailors Creek, between Daylesford and Leonards Hill, shows an exceptional profusion of zircons. They are associated with scarce corundum, pleonaste and abundant ilmenite. Most zircons belong to the Daylesford Group, but other types include short, pyramidal scarlet and, rarely, blue-green crystals of the

Group Name	Crystals	Normal colour	Prism:Pyramid	Size,mm.	Host rock	Localities
Newbury	BZ	Scarlet	0 – 1	0.5 – 20	Alk.ol.basalt	1, 3, 4, 6, 9, 18, 19, 20, 21, 22
Lyonville	aBZ, BZ, minor ABZ	Orange	0.2 – 2	0.2 – 1	Biot-anorthocl. trachyte	2, 3, 5, 6, 7, 8
Daylesford	BZ, minor ABZ	Mauve-orange	1 – 15	1 – 9	Alk.ol.basalt	9, 10, 11
Flinders	BYZ	Scarlet	0.2 – 3	0.2 – 2.5	Alk.basalt	12
Inverell	aBZ, minor aBZ, aByZ	Pale brown	0.2 – 3	1 – 25	Alk. basalt	20, 21, 28, 29
Nundle	aBYz, minor ABYz, BYz	Brown	0.2 – 1	1 – 12	Alk.ol.basalt	13, 16, 17, 20, 21, 27, 28
Elsmore	Same as Nundle	Mauve-orange	0.2 – 1	1 – 10	Trachytic tuff	14, 15, 20, 21, 23, 24, 25, 26, 28, 30
Boatharbour	BY, minor BYz	Scarlet	0.2 – 1	0.3 – 20	Ol.melilitite	31
Bullenmerri	B, BY, minor Bc	Yellow-brown	0 – 0.5	1.5 – 17	Basanitic tuff	32

Table 1. Morphologic groups of gem zircons from alkali volcanics, eastern Australia.

Localities:

1. Newbury, nr Trentham, V.
2. Blue Mountain, nr Trentham, V.
3. Blue Creek, nr Trentham, V.
4. South Bullarto, V.
5. Babbingtons Hill, Lyonville, V.
6. Loddon R. Lyonville, V.
7. Mt. Wilson, nr Bullarto, V.
8. Camels Hump, nr Woodend, V.
9. Leonards Hill – Daylesford, V.
10. Hepburns Lagoon, nr Newlyn, V.
11. 'Bullarook', Newlyn Area? (NMV Coll).
12. Point Leo, nr Flinders, V.
13. Tea Tree Ck, nr Lancefield, V.
14. Tumbarumba Area, NSW.
15. Oberon Area, NSW.
16. Duncans Ck, nr Nundle, NSW.
17. Brickclay Ck, nr Walcha, NSW
18. Rocky River Area, nr Uralla, NSW.
19. Tingha, NSW.
20. Elsmore Hill, nr Inverell, NSW.
21. Horse Gully, nr Inverell, NSW.
22. Oban, NSW.
23. Bald Nob, NSW.
24. Murphys Ck, nr Helidon, Q.
25. Ballogie, nr Proston, Q.
26. Brigooda, nr Proston, Q.
27. Mt. Moffat Area, Q.
28. Rubyvale – Sapphire, Q.
29. Tomahawk Ck, Hoy Prov., Q.
30. Lava Plains, Q.
31. Sisters Ck, Boatharbour, T.
32. Lake Bullenmerri, V.

Sample number	Mineral Locality	Number of grains	Standard track density $x10^6cm^{-2}$	Fossil track density $x10^6cm^{-2}$	Induced track density $x10^6cm^{-2}$	Correlation coefficient	Chi square test	Age Myr	Uranium ppm
8322–54	Mt Moffat, Qld	9	1.225 (5365)	1.032 (1175)	2.006 (2285)	0.994	pass	27.6±1.1	87
8322–70	Duncans Creek	10	1.225 (5365)	1.752 (1182)	1.555 (1049)	0.903	pass	60.4±2.7	68
8422–52	Elsmore Hill	12	1.225 (5365)	0.838 (881)	1.218 (1280)	0.915	pass	37.0±1.7	53
8422–53	Horse Gully	11	1.225 (5365)	0.950 (915)	1.418 (1367)	0.686	pass	35.9±1.6	62

Table 2. Analytical results: Fission track dating of zircons from New South Wales and Queensland. Brackets show number of tracks counted. Standard and included track densities measured on external detector surfaces and fossil track densities on internal surfaces (5=0.5). Ages calculated using Zeta = 87.9±0.64 for dosimeter glass U3. Age dating by Geotrack International, Geology Department, University of Melbourne.

Newbury Group, and occasional colourless, pale-green, yellow or pink anhedra of unknown group affinities.

4. Point Leo, near Flinders, Vic. Beach sands yield abundant concentrates of scarlet zircon, blue corundum, pleonaste and ilmenite up to 3mm. Zircons are heavily abraded and recognisable crystals are very rare. Only five were recovered from several thousand grains. These were all BYZ forms, indicating a distinct field, the Flinders Group. Zircospilic minerals appear to be eroding out of mid-Tertiary olivine basalts in the catchments of a nearby creek. Wave action has produced rich concentrates at the beach heads.

5. Horse Gully, east of Inverell, New England Sapphire Field, N.S.W.: Alluvial sapphire workings between Inverell and Glen Innes, on the New England Tablelands, yield abundant zircon, corundum, pleonaste, ilmenite and very rare diamond. Zircospilic alluvials are derived from Tertiary volcanics which have been extensively denuded. Spinel and rarely corundum occur as megacrysts in some basalts (MacNevin, 1972). Zircons near source areas are largely unabraded but show variable magmatic disequilibrium, corrosion and etching. Abrasion is more apparent in the Horse Gully occurrence where four distinct groups show little overlap

of characteristics. Crystal census details are given in Fig.3.

(a) Newbury Group: rounded to euhedral crystals range up to 17 mm, but are typically around 8 mm. Most are scarlet to deep orange-red; many being of gem quality. A few are brownish-red and transluscent. The majority are (100) + (101) forms, and rare acicular crystals show elongation of (100) consistent with growth into cavities. Short-wave U.V. fluorescence is nil to weak orange, and the group shows about four times normal background radioactivity.

(b) Inverell Group: these are the largest and most abundant zircons. They range from colourless through pale yellow-brown to colours almost indistinguishable from the brown type. Many crystals are of gem quality, being typically 12 mm and up to at least 25 mm. Original complete crystals many cm. across are indicated. The fragments are often blocky, strongly etched or smoothed, often with finely pitted surfaces. Euhedra are seldom sharp, and identifiable crystals are rare with gross distortions. Crystals show a large morphologic range, the majority being in the ABZ range. A multi-source series is suggested, perhaps including some lower temperature pegmatitic sources. Some crystals are flattened along (100) and show evidence of attachment (see below). Fluorescence is a brilliant yellow, and radioactivity is the lowest of any zircons tested.

(c) Elsmore Group: these are the least abundant zircons at Horse Gully, although elsewhere in the Glen Innes-Inverell districts they may be predominant. Rounded to sharp euhedra are typically 5 mm but range up to 10 mm. A pale mauve or lilac colour is characteristic, often with patchy distribution and colourless areas. A majority of crystals are in the low-prism, high-pyramid area of the classification system (Fig.2). Fluorescence ranges from weak to medium yellow, and radioactivity is about twice the normal background.

(d) Nundle Group: although zircons of this group show a similar range of crystal forms to (c), their orange-brown colour and slightly larger size than the Elsmore Group are distinctive.

A fission track date on Horse Gully zircon gives 35.9 Ma (Table 2) suggesting that the zircon source rocks are early Oligocene or older.

6. 'Braemar', near Elsmore Hill, New England Sapphire Field. A recently exposed section shows bedded pale-grey to brown 'trachytic' pyroclastics which yield abundant corundum, pleonaste and lesser zircon (Lishmund & Oakes, 1983). Zircons are unabraded and although most crystals are corroded, some are sharply crystallised. The assemblage shows considerable overlap of types and distinct grouping was impossible. However, all the types noted from Horse Gully are present but in different proportions.

Colour	Max. Size	Frequency	Group Affinity
Colourless	10 mm	Rare	Nundle & Elsmore
Pale yellow-brown	15 mm	Approx. 30%	Nundle & Inverell
Umber	15 mm	" 20%	Nundle
Orange-red	12 mm	" 25%	Newbury
Mauve-orange	12 mm	" 10%	Elsmore
Semi-opaques	Over 30 mm	" 15%	Newbury & Nundle

The Braemar pyroclastics are an important discovery as they provide a solution to a 'zircospilic supply' problem. The supply of zircospilic megacrysts from the basalts would not account for their abundance in the alluvials. Readily eroded pyroclastics rich in zircospilics may have been widespread and would have provided prolific sources of alluvial material. Remnants of pyroclastics are only likely where overlying basalts have afforded protection, as at Braemar.

The Elsmore zircon gives a fission track date of 37 Ma (Table 2) which, like the Horse Gully result, indicates an early Oligocene or older source.

7. Headwaters of Duncans Creek, east of Nundle, N.S.W. Weathered basalt beside the Nowendoc-Hanging Rock road at Fossicking Area No. 22, 10 km east of Nundle, yields abundant zircons, pleonaste, ilmenite and scarce corundum (Sutherland, *et.al.*, 1984). Zircons are colourless, through honey to deep orange-brown, and comprise a single Nundle Group. Crystals are extensively shattered and partly rounded by corrosion. Sizes range from 1 to 15 mm with a noteworthy absence of smaller crystals. Partial solution of the zircons indicates that they were not in equilibrium with their host alkali olivine basalt. Other basalts in the area appear zircon-free. A trondjhemite pluton 10 kms to the north, and a 'stressed' granite pluton 20 km NNE (Binns, 1967) indicate that granitic cumulate sources are a possibility; alternatively, a cognate origin in Tertiary fractionated basalts should be considered.

The Nundle zircons yield a fission track age of 60.4 Ma (Table 2) so that the host basalt is a small remnant of the earliest basalts erupted in the area (60-35 Ma; F.L. Sutherland & P. Wellman, in prep.). This age closely matches that of the Square Top theralite intrusion 3 km west of Nundle (60.1 Ma recalculated minimum age; McDougall & Wilkinson, 1967). This intrusion shows differentiation to a tinguaite end member (Joplin, 1971). Thus, nepheline syenite magma belonging to this may occur at depth to contribute zircons to associated basalt eruptions.

8. Anakie Sapphire Field, Central Qld. A large area, producing sapphire and gem zircon, with workings centered around The Willows, Tomohawk Creek, Sapphire-Rubyvale and Glenalba, is associated with Tertiary alkaline volcanics (Veevers *et.al.*, 1964). Country rocks consist of Palaeozoic granites and metamorphics, some of which contain small zircons. Gem zircons occur in post mid-Tertiary, high-energy alluvial spreads and most show major abrasion. Some rounded pebbles of zircon from Reward are fist-sized.

Crystals from the upper reaches of Policemans Creek, N.W. of Rubyvale are much less abraded, suggesting source regions westward towards the Drummond Range. Similar zircons have been recorded very rarely in basalts of the Anakie Field (Stephenson, 1976); sources that would appear inadequate to explain the abundant alluvial zircons. Zircons comprise three colour groupings:

(a) Pale yellow-brown, angular to rounded fragments, seldom showing crystal faces but closely resembling Inverell Group zircons.

(b) Brown to red-brown, mostly rounded crystals of Nundle Group, sometimes showing sharp crystals.

(c) Mauve-orange, mostly rounded crystals and fragments of the Elsmore Group; generally much less common than (a) or (b). In ordinary light, some crystals appear scarlet, but no orange-red (Newbury Group) zircons were noted in Reward-Rubyvale samples. Some of the yellow-brown zircons show strong colour zoning. Zircons appear to be about five times as common as corundum at Rubyvale, but pleonaste is distinctly rare.

9. Sisters Creek, near Boatharbour, Tas. Zircons are abundant in gravels associated with Tertiary basalts, with rarer spinel and blue corundum, in the Sisters Creek–Boatharbour area near Wynyard (Matthews 1973). They are mostly transparent, scarlet to orange-mauve; some showing patchy colouration, grading to colourless. Crystals show a strong predominance of (101) + (110) forms, some with minor (100) (See Fig.3). There is a large range of complex combinations with second- and third-order pyramids. Crystals show evidence of considerable magmatic corrosion, and abrasion is negligible. They are being shed into the local creeks from an olivine melilitite flow which is dated at 26 Ma (authors' unpublished data). They are associated with 'anorthoclase' derived from an underlying basalt flow. The range of crystals probably represents a low-temperature, dry, alkaline-plutonic source rock. The overlap of minor crystal types with the Elsmore, Nundle and Bullenmerri Groups is noteworthy, although the majority comprise a distinct assemblage.

10. Lake Bullenmerri, Western Vic. The recent maars at Lakes Bullenmerri and Gnotuk, southwest of Camperdown, are surrounded by basanitic tuffs and agglomerates. These contain large blocks of alkali gabbro (Grayson & Mahony 1910), basalt, Tertiary sediments and ultramafic nodules of upper mantle origin (Ellis, 1976; Hollis, 1981). Concentrated heavy mineral sand along a limited section of the eastern shore at Lake Bullenmerri contains abundant zircons (McMahon & Hollis, 1983) up to 17 mm in diameter. Elsewhere around the lakes, there are only a few small zircons. Colours are mainly pale orange-brown but range to straw yellow, pale greenish-yellow, white, colourless and dark brown. Colouring is sometimes patchy, perhaps due in part to localized minute inclusions. The zircons are non-fluorescent with radioactivity about 14 times that of the background. This may be due to inclusions of a radioactive mineral; some crystals do have conspicuous opaque black inclusions that resemble allanite. Crazing and fracturing are widespread, resulting in many broken crystals. This crazing may have occurred due to rapid cooling and depressurisation during transport in eruptions, or it may reflect metamictisation.

Many of the zircons occur as well developed crystals that show minimal corrosion or abrasion. The majority show only (101) forms and the remainder have variable development of (110) and (301) (Figure 3). According to the scheme proposed by Pupin (1980), crystals of these types, having high pyramid and low prism indices, formed in dry, alkaline plutonic source rocks at low temperatures.

The associated minerals in the beach sand appear to be of entirely deep-seated or volcanic origin and comprise black spinels, pyroxenes, olivine, amphiboles, garnets, ilmenite, biotite and anorthoclase. Corundum, normally associated with the zircon, was not found.

The Bullenmerri zircons appear to have been samples from a shallow-crustal alkaline body, of small dimensions, that was intercepted by one of the volcanic pipes. The zircons apparently come from the tuffs that accumulated around the eruption centre. The general lack of abrasion supports this local origin.

Zircon Host Rocks

Zircon megacrysts occur in many Tertiary to Cainozoic alkali basalts, trachytes, alkali breccias and intrusives. The chance of seeing a zircon *in situ* is low, as concentrations seldom exceed five crystals per cubic metre. Zircons in fresh basalts are known from the Anakie–Rubyvale, Cheviot Hills and Cooktown areas in Qld (Stephenson, 1976), east of Inverell (this study), northern N.S.W., near Armidale (Binns, 1969) and at Lake Learmonth, Vic. (National Museum of Victoria collection). Zircon is found with attached basalt near Mt Moffatt, Buckland Province, Qld (Australian Museum collection). A fission track date of 27.6 Ma (Appendix) suggests that the zircon was erupted during the main shield-forming stage of this volcano. Abundant zircon can be panned directly from weathered *in situ* basalt at Nundle and Boatharbour. Red euhedral zircons are common in late Tertiary to Quaternary alkali basalts and trachytes in the Trentham and Daylesford areas, central Vic. Zircons are about eight times as common in basalt at Newbury than in the nearby trachyte at Blue Mountain. Those occurring in basalts show considerable magmatic corrosion, but the trachytic zircons have sharp crystals which may be cognate. Crystals from different basalts of various ages (6–2.5 Ma) are physically identical, suggesting xenocrysts from a common source (J.D. Hollis, A. Gleadow, & D. Sewell in prep.).

A zircon-bearing xenolith in basalt is described from Rileys Peak near Bowral, N.S.W. (Wass & Irving 1976). A scarlet zircon crystal occurs in coarse anorthoclase of a type characterising alkaline rocks. It shows short

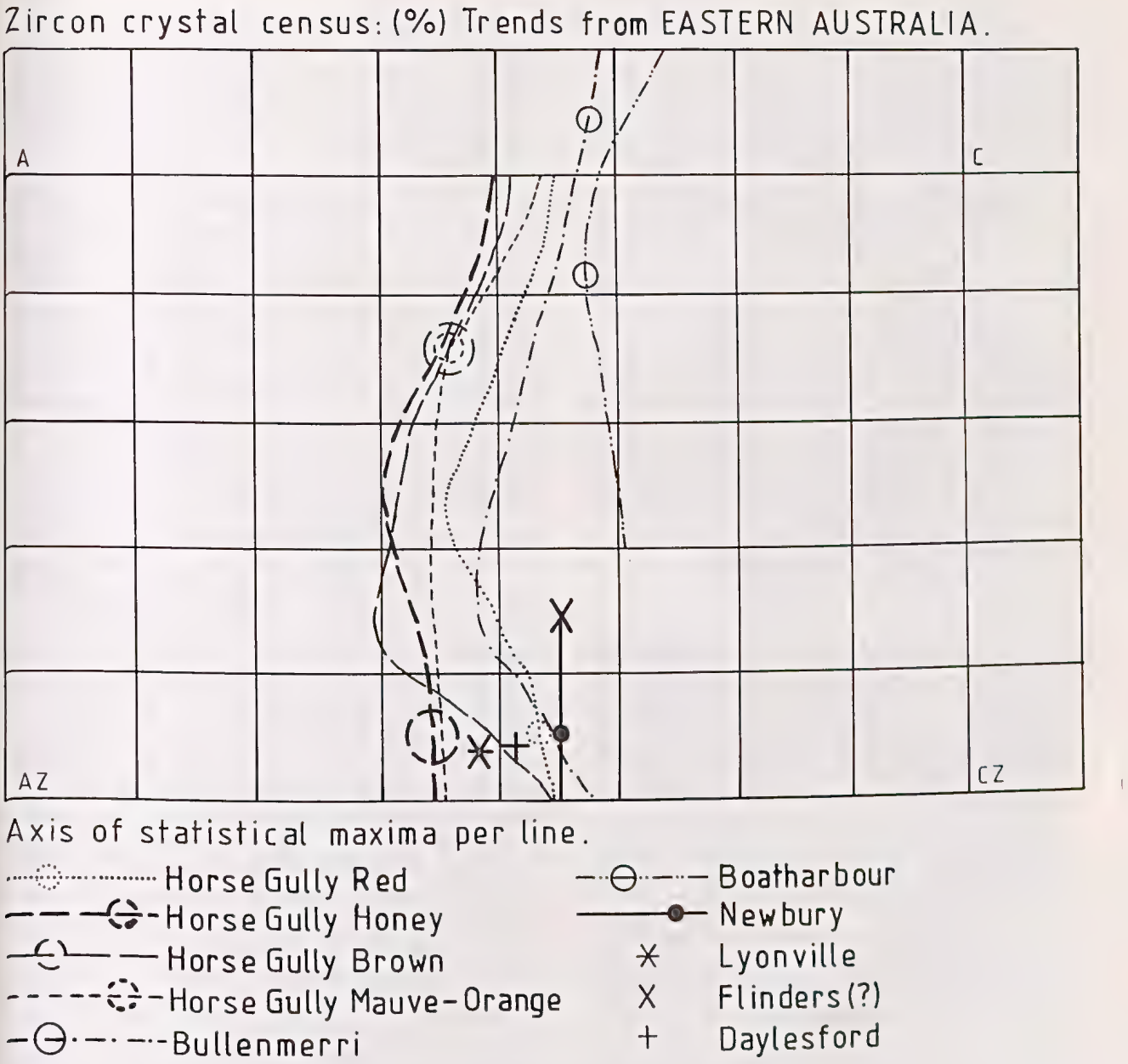


Fig. 4. Some crystallisation trends for large zircon groups in eastern Australia. Trend lines link statistical peaks of crystal type occurrence across each line. Circles show the maximum abundance stage for each group.

(110) prism development.

The zircon-bearing olivine melilitite flow at Boatharbour also contains rare xenoliths of a cumulate, olivine-bearing, nepheline syenite. No granitic or syenitic rocks are known to outcrop in the region. The nepheline syenite is probably related to Tertiary intrusions at depth. It may represent nepheline benmoreite magma associated with fractionated anorthoclase-bearing alkaline lava which outcrops below the melilitite flow.

Crystallisation Trends in Gem Zircons

Figure 4 shows a remarkably consistent set of crystallisation trends for gem zircons from eastern Australia. All groups counted, except Boatharbour, show commencement of crystallisation at the upper temperature extreme, developing (a)BZ crystal forms. The trend for the Flinders Group is poorly known and not discussed further. Gem zircons from Horse Gully and the Bullenmerri Group all show comparable trends with a right swing in the trend curve at the (a)ByZ or (a)BYZ stages. Crystallisation continued to the B or BY, low temperature forms. Peak crystallisation counts vary markedly between groups, with peaks independent of the trend curve swing. The Boatharbour trend is considerably to the right and commences with BYZ forms. The trend curve swing is at the BY crystal stage, much later than the other groups, and well to the right,

suggesting more alkaline environments. Daylesford and Lyonville Group zircons are restricted to (a)BZ forms, and the Newbury Group barely proceeds past ByZ. These trend lines may give evidence of magma fractionation histories, and changes in alkalinity, although lack of proven source rocks for the zircons makes it difficult to examine individual cases.

Causes and the significance of these trends are unknown and work on experimental melts will be necessary to solve the problems. However, a hypothetical model can be suggested to explain certain aspects of the trends.

At its maximum temperature (900–1100 °C), a slightly metaluminous, Zr-rich (over 1000 ppm), Zr-saturated magma may have most of its Zr held by alkali zirconosilicate counter-ions. The slight excess of free Zr will precipitate as BZ-type zircon crystals. As the magma cools, fractionation removes alkalis by the settling out of alkaline mineral phases that are less rich in alumina; the melt becomes peraluminous, counter-ions are removed and Zr far exceeds saturation capacity. Zircon precipitation increases to a peak before decreasing as low Zr concentrations are reached. At lowest temperatures BY crystals develop.

If a magma chamber's contents remain as a closed system, a complete succession of crystal forms will develop with a peak representing a peralumious stage, as recorded for the Horse Gully and Bullenmerri Groups. Where the magma erupts before significant cooling, as in the Lyonville, Daylesford and Newbury Groups in Victoria, none of the lower temperature crystal types will be present in the assemblage. A melt that is peralkaline may fail to crystallise any zircons until fractionation can render the melt peraluminous. Such a case may be illustrated by the Boatharbour Group.

Origins of Zircons

The zircons found in alkali volcanic rocks include possible cognate types in trachyte (Lyonville Group) and magacrysts of unknown provenance in basalts (other groups). Preliminary analyses of the zircons show differences in compositions that probably reflect diverse sources (D. Sewell, pers.comm.). The only definite trend so far detected in the zircon compositions is an increase of Hf content with increasing (110) prism development. This probably indicates a temperature control as magmas fractionate to lower-temperature, less mafic compositions. The absence of (110) prism development in the Newbury, Lyonville and Daylesford Groups probably indicates eruptive cutoff of crystal development before the lower temperature forms could be expressed.

Role of fractionating basalt magmas. Most basalts are peraluminous ($Na_2O + K_2O/Al_2O_3<1$). As Australian basaltic magmas fractionated to less mafic compositions, Zr increased in concentration as an incompatible element (Sutherland, 1980; Ewart *et.al.*, unpubl.ms.). This may eventually lead to zircon crystallisation. Experimental work (Watson, 1979) suggests that felsic, non-peralkaline magmas are likely to contain zircon crystals because of the low saturation level of zircon in such compositions. Irving & Frey (1984) considered that zircon megacrysts found in lineages are only likely to be phenocrystic in the extreme fractionation end members (trachytes, benmoreites and undersaturated associates).

The east Australian evidence suggests that zircons may develop from compositions as mafic as nepheline mugearite, based on the occurrence of euhedra up to 8 mm in a dyke at Brickclay Creek, N.S.W. This rock shows Zr abundances of 325–450 ppm (Stolz, 1984; authors' unpublished data). The rock is mantle-derived and almost exclusively contains mantle xenoliths, but the relationship of the zircon to mantle sources is uncertain. Zircons also occur in alkali basalts and 'trachytes' devoid of mantle inclusions and derived from likely fractionation at crustal levels (eg. Nundle, Elsmore Hill; Sutherland, *et.al.*, 1984).

If the fractionating magmas become peralkaline, extremely high concentrations of Zr can be held by counter-ions as alkali zirconosilicate complexes (Bowden, 1966; Linthout, 1984). The counter-ion effect may be broken down by crystallisation of alkali amphiboles and pyroxenes (Watson, 1979), which result in peraluminous conditions and consequently decreased solubility of Zr in the melts (Carmichael & McDonald, 1961; Watson, 1979). This leads to greatly increased precipitation of zircon crystals, possibly as cumulates, and depletion of Zr in the host rocks (Ewart, 1982). Lesser concentrations of cumulate zircon can be expected in melts that have had lower Zr concentrations than melts that have been peraluminous throughout their crystallisation history.

Distribution of fractionated basalt end members. The east Australian Tertiary and possibly the Mesozoic volcanic/intrusive provinces include migratory 'hot spot' trails in which volcanoes develop felsic fractionates such as trachytes, rhyolites and leucitites (Wellman, 1983; Sutherland, 1983). Cognate zircons are known in these rocks in the Lyonville trachytes (Tertiary) and the Jingera syenite (Jurassic). We consider that the trachytes around Lyonville (5.9–6.1 Ma: Ewart *et.al.*, unpublished ms) probably evolved from K-rich understaturated magmas introduced into Victoria by that time (K-rich nepheline mugearites and olivine leucitites, 6.7 Ma: Irving & Green, 1976; Birch, 1976), increasing their Zr contents and opportunities for changing to peraluminous precipitation conditions. The Jingera syenite includes both quartz and nepheline normative rocks developed from a transitional basalt source rock at about the crust-mantle boundary. It shows high Zr/Nb contents and large zircon crystals (in conference talk given by Beams *et.al.*, 1983).

A large number of intrusive bodies of these fractionated felsic rocks probably exists under the main 'hot spot' volcanoes and possibly also under the migration lines where volcanic activity had not resulted. Many of these will provide potential reservoirs of zircon crystals/cumulates which may be brought up as xenocrysts during subsequent basaltic eruptions.

If zircon is also crystallised from nepheline mugearite, 'tinguaite' and mafic nepheline benmoreite magmas (Walcha, Nundle, N.S.W.; Boatharbour, Tas.) this would increase the number of potential reservoirs that could yield xenocrysts in later eruptions. Thus the widespread occurrence of zircon is the suspected function of extreme fractionation processes operating over some 220 million years.

Older zircon sources. Some of the megacryst zircons from the volcanic rocks are noteworthy for their large size and strong zoning, but confirmed reports of zircon in Palaeozoic pegmatites are generally absent. Many of these may be coming from peraluminous and mostly dry Palaeozoic granitoids (A Type of E. Australia, Collins *et.al.*, 1982). The largest and most diverse zircons come from the Inverell Group which occurs within the Permian New England batholith, a composite of four major magmatic episodes (312–232 Ma) ranging in composition from nepheline normative to highly felsic 'granites' (Hensel *et.al.*, 1982). The Inverell Group shows crystallisation over a considerable temperature range. Pegmatitic bodies in granitoids at depth could provide some of these.

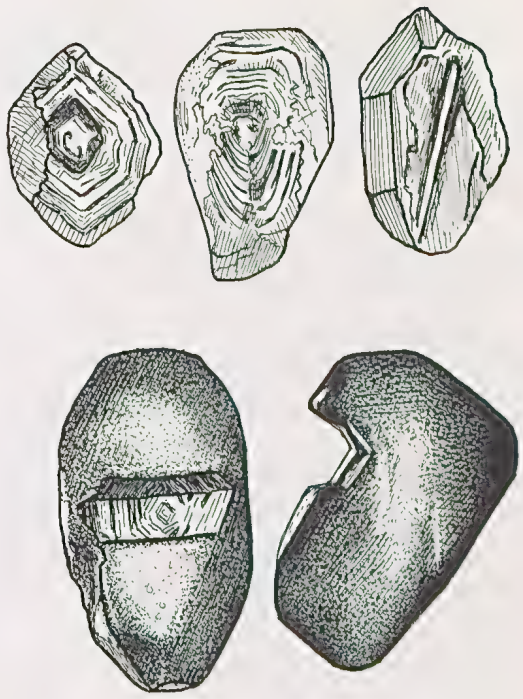


Fig. 5. Upper row: deformed zircon crystals from 'Braemar', Elsmore Hill, N.S.W., suggesting former attachment: **Left:** stepped-convex side of crystal, parallel to C axis, X2. **Centre:** similar crystal, with stepped-convex side at right angles to C axis, X3. **Right:** angular-profiled, straight trough of former acicular crystal phase, X20. **Lower row:** abraded Elsmore Group crystal from Reward, near Rubyvale, Qld., showing negative of former attached crystal, perhaps apatite, X20. Drawings: K.A. Hollis.

Crystal Growth Sites

Cored zircons are frequent in granitoids derived from crustal anatexis (eg. Gulson & Krogh, 1975). Cores are zircons derived from pre-existing rocks that provided nucleii for the magmatic zircons. None of these cores have yet been found in the large crystals examined.

Many crystals are completely developed and appear to have grown freely in parent magmas. However, most larger crystals from the New England and central Queensland sapphire fields, belonging particularly to the Inverell and Nundle Groups, show features suggesting attachment during growth. These are:

(i) a virtual absence of complete euhedra;

(ii) a high frequency of flattened to tabular-elongate crystals;

(iii) the presence of stepped, convex faces (Fig.5);

(iv) the common development of straight, angular-profiled channels across one face, suggesting former attachment to another mineral. Apatite and rutile are possibilities as these occur as inclusions;

(v) the large size and strong zoning of crystals.

One of several possible models involves zircon growth on magma chamber or conduit walls, perhaps on suitable nucleii exposed on the magma-wall rock interface. Gradual melting of wall rocks would release attached zircons and expose fresh growth nucleii. The crystals may then settle through the magma to form cumulates. The enhancement of zircon crystallisation on magma chamber walls may result from increased fractionation of alkali-rich minerals in slightly cooler regions near contacts, rendering the magma peraluminous in their vicinity. The main body of the magma being less aluminous may show little or no free zircon development.

Subsequent violent outgassing via the magma chamber with its content of zircons would produce the zircon-rich pyroclastics seen at Elsmore Hill. Zircons stripped directly from the walls would show negligible corrosion; whereas those from the cumulates that were surrounded by less aluminous magma are likely to be partly dissolved and hence corroded. Both types of crystal preservation are widespread in the sapphire fields.

Conclusions

Large zircons from eastern Australia have diverse origins, few of which have been positively identified. Host rocks are generally alkali basalts, trachytes and their related pyroclastics. Most zircons from basalts are corroded, indicating disequilibrium with their host magmas. Their large sizes, strong zoning and morphologic diversity favours plutonic sources, mostly unrelated to their host rocks. Origins could include:

1. Crystallisations from peraluminous trachytes, for example the Lyonville Group in the Woodend Tertiary trachytes.

2. Syenitic magma chambers connected with the widespread Mesozoic-Cainozoic volcanism. Some zircon-bearing basalts have not been erupted through granitic country rocks, suggesting that these zircons may have crystallised in strongly fractionated magma chambers. Many crystals may have developed attached

to the walls of these chambers, subsequently being carried to the surface in basaltic eruptions.

3. Cumulates in peraluminous alkali granitoid plutons, associated intrusives and metamorphics, related to the widespread crustal melting events of the Palaeozoic. The large Inverell Group zircons are candidates for such sources.

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